Soluble Salts

by Sue Bottom, sbottom15@hotmail.com

Good quality water is the “holy grail” for orchid growers. The better your water, the better your orchids will grow and the greater the variety of orchids you will be able to cultivate. Good quality water should contain a low level of soluble salts. Salts dissolved in water gradually accumulate in potting media and around roots with every watering/drying cycle. If not flushed from the pot, salts can build up to toxic levels and cause root tip burn, which limits root growth.

Soluble Salts. There are two standard measures of the soluble salt content in water. Electrical Conductivity (EC) is a measure of water’s capacity to conduct electricity and a direct measure of the concentration of various ions in water, measured in mS/cm with an EC meter. Total Dissolved Solids (TDS) is most accurately measured in the laboratory by evaporating a fixed amount of water and weighing solids left behind. Most hobbyist meters use a conversion factor to calculate TDS in parts per million from the measured EC. Knowing the soluble salts content is the first step in evaluating the suitability of your water for growing orchids.

Table 1 – **Soluble Salts – A Quick Measure for Evaluating Your Water Quality**

Quality	Electrical Conductivity (Mhos)	Electrical Conductivity (mS/cm)	Total Dissolved Solids (ppm)
Excellent Quality	$< 25 \times 10^{-5}$	< 0.25	< 175
Good Quality	$25 – 75 \times 10^{-5}$	0.25 – 0.75	175 – 525
Questionable Quality Use with Caution	$75 – 125 \times 10^{-5}$	0.75 – 1.25	525 – 875
Unsatisfactory Quality - Find a New Water Source	$> 125 \times 10^{-5}$	> 1.25	> 875

Conductivity is a measure of water’s capability to conduct electricity, which is directly related to the concentration of ions in water. It is usually measured in micro- or millisiemens per centimeter (uS/cm or mS/cm), less commonly in micromhos or millimhos/centimeter (umhos/cm or mmhos/cm). One siemen is equal to one mho.
Total dissolved solids (TDS) is the amount of all ion particles dissolved in water, reported in units of mg/l or ppm. TDS can be measured by gravimetry (with an evaporation dish) or calculated by multiplying a conductivity value by an empirical factor, typically between 640 and 700 ppm TDS per unit of conductivity in mS/cm, the conversion above uses a factor of 700.

Sources: Davidson 1967, Sheehan 2002.

Soluble salts can be beneficial, benign or potentially toxic. Calcium and magnesium are macro micronutrients and required for essential plant growth processes, but in high enough concentrations they can be interfere with the uptake of other nutrients. Bicarbonate and carbonate compounds (measured as alkalinity) are not nutrients and can accumulate in potting mixes, driving up pH and making important nutrients more difficult for roots to absorb. Some substances like sodium, chloride and boron are required in very small amounts for

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plant metabolism, but toxic for orchids even at levels where water is acceptable for human consumption. Salt water intrusion is a major cause of high sodium/chloride concentrations, but not the only one.

Best Water. Water with a conductivity below 0.25 mS/cm is considered excellent for orchids, i.e. a TDS <175 ppm. Typical rainwater and some groundwater obtained from non-shell strata in our area would be in this range. The Hastings public water supply is the only one in our area that supplies this high quality water. Rainwater contains very little buffering capacity to resist changes in pH and requires a fertilizer that will produce the desired slightly acidic conditions around your roots, without imparting too much acidity. A Cal Mag fertilizer like a Peter's Excel 15-5-15-5-2 that supplies supplemental calcium and magnesium does best with this pure water. Absence of soluble salts in water allows even cloud forest orchids e.g. many Masdevalias and Pleurothalids that are sensitive to even tiny levels of soluble salts, to grow well.

Good Water. Good quality water could range in EC from 0.25 to 0.75 mS/cm, roughly equivalent to a TDS level between 175 and 525 ppm. This would be typical of the municipal water in a few selected areas in St. Johns County, including Hastings, Ponte Vedra, the City of St. Augustine and St. Augustine Beach. Some private wells in the Jacksonville area also tap into good quality water, though this is the exception in St. Johns County.

Questionable Water. Water with an EC between 0.75 and 1.25 mS/cm (roughly equivalent to 525 – 825 ppm TDS) is considered marginally suitable for orchids. This would be typical of many private wells in St. Johns County as well as the majority of the public water supply systems. At these elevated EC levels, it is imperative to know what soluble salts are present in the water. If salts are mostly associated with alkalinity or hardness of water, then the issue is the potential for the root zone to become more and more alkaline with each watering. However, if soluble salts present include sodium and chloride, there is a potentially severe problem in that these salts can be toxic to your orchids at relatively low concentrations.

Unsuitable Water. Water with an EC >1.25, equivalent to a TDS > 875 ppm, and water that contains toxic levels of sodium and chloride should not be used on your orchids. You should find an alternate water source or treat your water to remove salts.

Private Wells. In St. Johns County, private wells tap into either the shallower surficial aquifer or the deeper Florida aquifer. The surficial aquifer consists of interbedded sand, shell and clay that occur to a depth of about 120 ft. The water quality of the surficial aquifer is highly variable. In some areas, soluble salt levels range from acceptable to excessive. Highest salt levels are in coastal areas where the aquifer is interconnected with marine water as well as in farming areas around Hastings and Elkton.

Deeper wells tap the Florida Aquifer within the Ocala limestone. The Florida Aquifer generally contains more solids than the surficial aquifer because water resides in porous limestone rock for a long time. The saline (sodium chloride) content in the upper part of the

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Florida aquifer ranges from very low levels in the northwest part of St Johns county to extremely high levels along the southeast coast. Water from the southern two thirds of the county probably is probably too saline than is desirable for orchid cultivation. Levels of hardness (calcium and magnesium levels) and sulfate concentrations are far in excess of desirable levels in the northern part of the county and along the St. Johns River, which can interfere with the uptake of required nutrients.

Table 2 –**Water Quality in the Surficial and Florida Aquifer in St. Johns County**

	Suitability for Irrigation		Surficial Aquifer		Florida Aquifer	
	Target	Acceptable	Average	Range	Average	Range
Depth, ft			63	25-107	435	198-1014
pH, units	5.5 – 7.0	4 – 10	7.2	6.7 – 7.7	7.5	7.2 – 7.9
EC, mS/cm	<0.75	<1.5	0.7	0.4 – 1.7	1.8	0.2 – 10.7
TDS, ppm	<525	<1050	468	289-1176	1252	149-7490
Alkalinity, ppm	40 - 160	<400	266	138 - 369	106	33 - 170
Calcium, ppm	25 - 75	<150	92	34 - 130	151	72 - 280
Magnesium, ppm	10 - 30	<50	8	1 - 34	71	21 - 240
Iron, ppm	<1	<4	0.4	0 – 2.8	NA	NA
Sodium, ppm	<20	<50	28	8 - 180	189	9 - 2200
Chlorides, ppm	<20	<140	46	9 - 310	335	5.2 - 3500
Sulfates, ppm	<120	<240	50	1 - 180	412	16 - 1285

Source: Suitability for Irrigation from QAL Lab Reports, Groundwater data from Groundwater Resources of St. Johns County, 1984, NA means data not available. Numbers in red fall outside the acceptable range for orchid cultivation.

If you use a private well for your orchids, consider having the water tested. Contact me if you want quick analysis of your soluble salt content. If the preliminary results indicate a potential problem, you should send a sample off for a more detailed analysis. For $40, QAL will analyze your water. Please send any lab reports you have for your well water, so we can develop a more comprehensive database of well water quality in the area.

Data from SAOS members are compiled here for illustrative purposes. Clearly water derived from wells varies widely in quality. In Baker and Duval Counties, well data we have suggests good quality water is available. In St. Johns and Putnam counties data suggest that well water ranges from questionable to unsuitable for orchid cultivation. Excessively high TDS levels are occasionally encountered. In some cases, salt water intrusion is the cause an the levels of sodium and chloride are too high for using on orchids. In other cases, the calcium

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and sulfate levels are what contribute to excessive salt levels. Consider having your water analyzed. The data will tell you whether you can adapt your cultural practices to adapt to the limitations of your water, or whether there are specific ions present that are present in toxic amounts.

Table 3 - **Selected Water Quality Parameters for SAOS Members Well Water in the Area**

County	EC (mS/cm)	TDS (ppm)	Sodium (ppm)	Chloride (ppm)
Desirable & Max Levels	*<0.75 1.25 max*	*< 525 825 max*	*< 10 50 max*	*< 30 100 max*
Baker - Heinz	0.21	141*	3.0	5.8
Duval - Arnold	0.44	295*	27.5	43.0
Duval - Brickell	0.35	234*	9.9	18.5
Duval - Hackney	0.14	94*	13.0	36.7
Putnam - Stewart	**1.6***	**1100**	**89.4**	**273.7**
St. Johns - Bottom	0.9	603*	35.6	65.0
St. Johns - Croft	**1.6**	**1060**	12.9	18.0

*EC calculated based on factor of 670 ppm TDS/1 mS/cm EC, ND – None-detected

Public Water Supplies. These utilities obtain water from the Florida aquifer wells and use a combination of treatment steps including aeration and sometimes softening, desalinization and reverse osmosis to provide potable water. This map shows the water treatment utility serving your area. Only the Hastings system provides excellent quality water.

Water that is considered good for orchid culture is provided in Ponte Vedra, the City of St. Augustine and St. Augustine Beach. Water from these utilities typically has a pH a little higher than desirable, but alkalinity levels are generally low. pH is a measure of how acidic (below 7) or basic (above 7) the water is and alkalinity is a measure of how resistant water is to downward changes in pH. Water with low levels of alkalinity can more easily be made acidic by choosing a water soluble fertilizer with an acidic reaction, one that contains up to half its nitrogen in the ammoniacal form, like a 20-20-20, 20-10-20 or 21-5-20.

The World Golf Village and Bartram Oaks have elevated soluble salt levels, but levels of the potentially toxic sodium and chloride levels are within acceptable ranges. Ideally, sodium levels should be <10 ppm. Problems can arise at concentrations >50 ppm. Water with high levels of calcium will help ameliorate high sodium levels. Sodium is a greater problem in water with relatively low levels of calcium. If slightly high levels of sodium are present in your water, alternating your acid generating fertilizer with a Cal Mag fertilizer like a Peter's Excel 15-5-15-5-2 can help.

Most of the public water supply in St. Johns County, including the Nocatee area that is supplied by water purchased from JEA, would be classified as questionable based solely on the total dissolved solids levels. Much more troublesome are the sodium and chloride levels

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reported for these utility service areas, well above the level considered to have toxic effects on orchids.

Table 4 - **Selected Water Quality Parameters in St. Johns County**

Treatment Plant	pH (units)	Alkalinity (ppm)	Calcium (ppm)	Magnesium (ppm)	TDS (ppm)	Sodium (ppm)	Chlorides (ppm)
Desirable & Max Levels	*6 – 7.5*	*< 150*	*40 - 100*	*20 – 50*	*< 525 825 max*	*< 10 50 max*	*< 30 100 max*
Mainland (Most of St. Johns County)	8.6	55	N/A	N/A	720	**120**	**210**
Northwest (World Golf Village)	7.8	131	N/A	N/A	550	25	35
Northeast (Nocatee from JEA)	8.3	126	60	N/A	141- **846**	8 – **115**	9 - **329**
Bartram Oaks	7.9	107	N/A	N/A	660	15	26
Hastings	7.9	96	N/A	N/A	14	4.6	6.8
Ponte Vedra	7.4 – 7.8	122-146	54 - 63	N/A	460 - 500	18 – 23	27 - 38
St Augustine, St Aug Beach	7.6	51	68	38	524	14	32

A range of values is given for the Northeast because the JEA purchased water draws from wells of variable quality. Barry Stewart , Dan Nolwaczyk and Allen Klipstine of the St. Johns County Utility Dept. and Patrick Timoney of the City of St. Augustine Water Dept. graciously supplied water quality data (February, 2019).

Club member Linda Stewart identified and corrected the problem with her excessively salty water by installing a rainwater collection system, read her companion article for details. James Arnold of the Jacksonville Orchid Society went a different route, installing a reverse osmosis system to remove salts. His companion article will give you some things to consider, should you decide to go that route.

The problem with elevated soluble salt levels is that orchids are efficient scavengers of nutrients. In their natural environment, mineral nutrients are rare, so orchids have evolved to absorb every atom they encounter, potentially producing toxic levels in their tissues in cultivation. You can compensate to a degree for elevated salt levels with your cultural practices. Do not use this water for misting or for overhead watering. Use dilute fertilizer solutions. Water more frequently than you might otherwise to prevent the medium from completely drying out and concentrating salts. Use plastic containers that will not absorb salts. When you water, do so until water runs through pots and then water some more. Flush pots regularly. Salts can be flushed more easily from an open, freely draining potting mixes

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than they can from water retentive mixes containing sphagnum moss or peat, which tend to accumulate salts. Get in the habit of watering and fertilizing and then water a second time an hour later, ideally with rainwater if you have it. Move plants outdoors in summer so they can be flushed naturally with rainwater.

I have struggled for many years with the quality of my well water. The EC/TDS levels are in the questionable range and the alkalinity is very high. High alkalinity levels in water causes a buildup of lime salts, i.e. high pH in media. The pH around roots needs to be in the slightly acidic range for best absorption of nutrients. Citric acid is currently added to the water to remove some bicarbonates and reduce the root zone pH. However, the slightly elevated level of sodium and chlorides makes growing certain genera problematic. Paphiopedilums, dendrochilums, and other salt sensitive genera are moved into the shade structure to receive rainwater from spring through fall. We are exploring the possibility of installing a reverse osmosis system to treat the well water in the house and in the greenhouse..

If you know only one thing about your water, know what the soluble salt content is. Good quality water containing low levels of dissolved salts will allow you to grow many different genera of orchids. You can compensate for somewhat elevated levels by adjusting your potting mixes and watering habits. For those unlucky few whose water is unsuitable for orchids, collecting rainwater may be a cost effective solution. Understanding the soluble salt level in your water will help you grow the best and healthiest orchids.

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