



Cape Water Tech

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South African Water Quality Guidelines

Volume 4 -- Agricultural Use: Irrigation

Target Water Quality Ranges and restriction bands for all 30 parameters covered by the Department of Water Affairs & Forestry's 2nd-edition guideline (1996), plus the supporting per-crop tolerance tables for sodicity (SAR/ESP), chloride and general salinity.

Source: DWAF, 2nd Edition, 1996

Compiled by Cape Water Tech (Pty) Ltd

Full interactive version with a searchable crop-lookup tool:

capewatertech.capetown/irrigation_water_quality_guidelines.html

Salinity -- Total Dissolved Solids / Electrical Conductivity

Table 1, p.165

TDS and EC are directly related -- EC is measured routinely as a proxy for TDS. $EC \text{ (mS/m at 25C)} \times 6.5 = TDS \text{ (mg/L)}$ -- document's stated factor, true range 5.5-7.5 depending on ionic composition.

EC (mS/m)	= TDS (mg/L)	Crop yield outcome
<= 40	<= 260	Target range -- salt-sensitive crops grow with no yield decrease under low-frequency irrigation; leaching fraction up to 0.1 may be required
40 - 90	260 - 585	95% relative yield, moderately salt-sensitive crops, low-frequency irrigation
90 - 270	585 - 1,755	90% relative yield, moderately salt-tolerant crops, leaching fraction up to 0.15
270 - 540	1,755 - 3,510	80% relative yield -- requires high-frequency irrigation, leaching fraction up to 0.2
> 540	> 3,510	Usable for selected crops only with sound management; sustainability drops rapidly as EC rises further

Table 2 -- Relative Salt Tolerance of Various Commercial Crops at Germination (after Ayers & Westcott, 1985)

The main criteria above don't account for growth-stage differences -- germination is markedly more salt-sensitive for some crops. EC of the saturated soil extract causing a 50% reduction in emergence.

Crop	EC (mS/m) -- 50% emergence reduction
Barley	1 600 - 2 400 mS/m
Cotton	1 550 mS/m
Sugarbeet	500 - 1 250 mS/m
Sorghum	1 300 mS/m
Safflower	1 230 mS/m
Wheat	1 400 - 1 600 mS/m
Beet, red	1 380 mS/m
Lucerne	820 - 1 340 mS/m
Tomato	760 mS/m
Rice	1 800 mS/m
Cabbage	1 300 mS/m
Muskmelon	1 040 mS/m
Maize	2 100 - 2 400 mS/m
Lettuce	1 140 mS/m
Onion	560 - 750 mS/m
Bean	800 mS/m

Table 3 -- Commercial Crops Classified by General Salt Tolerance (After Maas, 1990 / Ayers & Westcott, 1985)

Grouped by crop family across sub-tables 3a-3c below.

Table 3a -- Fruit & Nut Crops

Sensitive Almond; Apple; Apricot; Avocado; Blackberry; Boysenberry; Cherimoya; Cherry, sweet; Cherry, sand; Currant; Gooseberry; Grapefruit; Lemon; Lime; Loquat	Mod. sensitive Mango; Orange; Passion fruit; Peach; Pear; Persimmon; Plum/prune; Pomelo; Raspberry; Rose apple; Sapote, white; Strawberry; Tangerine	Mod. tolerant Castorbean; Grape	Tolerant Fig; Jujube; Olive; Papaya; Pineapple; Pomegranate	Very tolerant Date palm; Guayule; Jojoba
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Table 3b -- Vegetables

Sensitive	Mod. sensitive	Mod. tolerant	Tolerant
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Bean; Carrot; Okra; Onion; Parsnip; Pea	Broccoli; Brussels sprouts; Cabbage; Cauliflower; Celery; Maize, sweet; Cucumber; Eggplant; Kale; Kohlrabi; Lettuce; Muskmelon; Pepper; Potato; Pumpkin; Radish; Spinach; Squash, scallop; Sweet potato; Tomato; Turnip; Watermelon	Artichoke; Beet, red; Squash, zucchini	Asparagus
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Table 3c -- Fibre, Seed & Sugar Crops

Sensitive	Mod. sensitive	Mod. tolerant	Tolerant
Bean; Guayule; Rice, paddy; Sesame	Broadbean; Castorbean; Maize; Flax; Millet, foxtail; Groundnut/peanut; Sugarcane; Sunflower	Cowpea; Kenaf; Oats; Safflower; Sorghum; Soybean; Wheat	Barley; Cotton; Guar; Jojoba; Rye; Sugarbeet; Triticale; Wheat, Durum

Table 3d -- Grasses & Forage (reproduced as continuous text -- see note)

This sub-table packs many multi-word species names per cell in the source with no per-item delimiter; boundaries reconstructed for readability, cross-checked against the standard Maas (1990) forage table.

Sensitive	Mod. sensitive	Mod. tolerant	Tolerant
None	Alfalfa (lucerne); Bentgrass; Bluestem, Angleton; Brome, smooth; Buffelgrass; Burnet; Clover, alsike; Clover, Berseem; Clover, ladino; Clover, red; Clover, strawberry; Clover, white Dutch; Cowpea (forage); Dallis grass; Foxtail, meadow; Grama, blue; Lovegrass; Maize (forage); Milkvetch, Cicer; Oatgrass, tall; Oats (forage); Orchard grass; Rye (forage); Sesbania; Siratro; Sphaerophysa; Timothy; Trefoil, big; Vetch, common	Barley (forage); Brome, mountain; Canary grass, reed; Clover, Hubam; Clover, sweet; Fescue, meadow; Fescue, tall; Harding grass; Panic grass, blue; Rape; Rescue grass; Rhodes grass; Ryegrass, Italian; Ryegrass, perennial; Sudan grass; Trefoil, narrowleaf birdsfoot; Trefoil, broadleaf birdsfoot; Wheat (forage); Wheat, Durum (forage); Wheatgrass, standard crested; Wheatgrass, intermediate; Wheatgrass, slender; Wheatgrass, western; Wildrye, beardless; Wildrye, Canadian	Alkali grass, Nuttall; Alkali sacaton; Bermuda grass; Kallar grass; Saltgrass, desert; Wheatgrass, fairway crested; Wheatgrass, tall; Wildrye, Altai; Wildrye, Russian

Table 4 -- Ornamental Shrubs, Trees & Ground Covers (After Maas, 1990)

Same caveat as Table 3d above -- cultivar annotations reconstructed for readability.

V. sensitive	Sensitive	Mod. sens.	Mod. tol.	Tolerant	V. tolerant
Star jasmine; Pyrenees cotoneaster; Oregon grape; Photinia	Pineapple guava; Chinese holly, cv. Burford; Rose, cv. Grenoble; Glossy abelia; Southern yew; Tulip tree; Algerian ivy; Japanese pittosporum; Heavenly bamboo; Chinese hibiscus; Laurustinus, cv. Robustum; Strawberry tree, cv. Compact; Crape myrtle	Glossy privet; Yellow sage; Orchid tree; Southern magnolia; Japanese boxwood; Xylosma; Japanese black pine; Indian hawthorn; Dodonaea, cv. atropurpurea; Oriental arborvitae; Thorny elaeagnus; Spreading juniper; Pyracantha, cv. Gruberi; Cherry plum	Weeping bottlebrush; Oleander; European fan palm; Blue dracaena; Spindle tree, cv. Grandiflora; Rosemary; Aleppo pine; Sweet gum	Brush cherry; Ceniza; Natal plum; Evergreen pear; Bougainvillea; Italian stone pine	White iceplant; Rosea iceplant; Purple iceplant; Croceum iceplant

pH

p.127

A three-way effect -- pH outside range disturbs crop yield/quality, soil nutrient availability, and irrigation equipment simultaneously.

pH	Crop yield & quality	Soil / nutrient	Irrigation equipment
< 6.5	Increasing foliar damage risk when wet; possible yield/quality reduction	Increasing unavailability of micro-/macro-nutrients; some become toxic	Increasing corrosion of metal and concrete
6.5 - 8.4	Target range -- no foliar damage expected	No major nutrient availability problems	Mostly no corrosion/encrustation; slight-moderate drip clogging risk
> 8.4	Increasing foliar damage affecting yield/visual quality	Increasing unavailability of micro-/macro-nutrients	Increasing pipe encrustation, drip clogging

Sodium Adsorption Ratio (SAR)

p.141 -- governs sodic-soil risk, derived from Na / Ca / Mg concentrations

SAR	Effect (root uptake, foliage not wetted)
<= 2.0	Target range -- prevents sodium toxicity in sensitive plants
2.0 - 8.0	Most sodium-sensitive crops absorb toxic levels through roots
8.0 - 15.0	Sodium-sensitive crops absorb toxic concentrations (varies by crop)
> 15.0	All sodium-sensitive crops affected; even tolerant crops increasingly absorb toxic sodium

Table 2 -- Effects on Soil Physical Conditions

SAR's effect on infiltration/hydraulic conductivity is EC-dependent -- a higher irrigation-water EC offsets SAR's destabilising effect on soil structure.

SAR	Infiltration rate	Hydraulic conductivity & hardsetting
<= 1.5	Target range -- adequate infiltration for sensitive soils under rainfall or irrigation with EC < 20 mS/m	No significant reduction expected for any soil
1.5 - 3.0	Problems likely in sensitive soils unless irrigation EC exceeds ~20-90 mS/m	No significant reduction expected for any soil
3.0 - 6.0	Problems likely unless irrigation EC exceeds ~25 mS/m	Reduction likely in sensitive soils; may be irreversible in low-EC soil solution; hardsetting likely below ~120 mS/m
6.0 - 12.0	Problems likely unless irrigation EC exceeds ~35 mS/m	Reduction likely, up to a large % in sensitive soils; hardsetting likely below ~120-240 mS/m
12.0 - 20.0	Problems likely unless irrigation EC exceeds ~90 mS/m	Reduction likely, up to <25% in less sensitive soils; hardsetting likely below ~240-400 mS/m
> 20	Problems likely unless irrigation EC exceeds ~180 mS/m	Reduction likely, up to <25% in less sensitive soils; small reversible changes at EC 100-200 mS/m

Table 4 -- Susceptibility of SA Soil Types to Physical Deterioration due to ESP-EC Interactions

Soil physical reaction	Sensitive	Medium	Tolerant
Infiltration rate	G, I, E	B, D, A, J	C, F, H
Hydraulic conductivity	G, F, E, I	B, J	A, C, H
Hardsetting	E, G, J	I, A, B	C, D, F, H

Letters refer to SA soil groupings, e.g. A = Hutton/Clovelly/Shortlands (freely drained), G = Estcourt/Sterkspruit/Kroonstad (texture-contrast, poorly drained). Full legend on the live web reference.

Table 3 -- Relative Tolerance of Crops to Exchangeable Sodium Percentage (ESP)

Tolerance decreases down each column; tolerances are relative -- nutritional and physical soil factors often limit growth before the listed ESP is reached.

2 - 15% ESP	15 - 40% ESP	> 40% ESP
Avocado; Deciduous Fruits; Grapes; Nuts; Beans (green); Cotton (at germination); Maize; Peas; Grapefruit; Orange; Peach; Tangerine; Mungbean; Mashbean; Lentil; Groundnut; Gram; Cowpeas	Carrot; Clover, Landino; Dallisgrass; Fescue, tall; Lettuce; Sugarcane; Berseem; Benji; Raya; Oat; Onion; Radish; Rice; Rye; Ryegrass, Italian; Sorghum; Spinach; Tomato; Vetch; Wheat	Lucerne; Barley; Beet, garden; Beet, sugar; Bermuda grass; Cotton; Paragrass; Rhodes grass; Wheatgrass, crested; Wheatgrass, fairway; Wheatgrass, tall; Karnal grass

Sodium -- Foliar Absorption (Sprinkler Irrigation)

p.155

mg/L	Effect
<= 70	Target range -- prevents toxic accumulation even with wet foliage
70 - 115	Sensitive crops: foliar injury, yield decrease
115 - 230	Moderately sensitive crops affected
230 - 460	Moderately tolerant crops affected
> 460	Tolerant crops increasingly affected

Chloride

p.51 -- two pathways: root absorption (surface/drip) vs. foliar absorption (sprinkler, wets foliage)

mg/L	Root absorption	Foliar absorption
<= 100 / < 140	Target range -- prevents toxicity even in most sensitive plants (< 140 mg/L, root pathway)	Target range -- prevents toxicity even in most sensitive plants (<= 100 mg/L, foliar pathway)
100 - 175	--	Sensitive crops: foliar injury, yield decrease
140 - 175	Slight problems	--
175 - 350	Some problems, moderately sensitive crops	Moderately sensitive crops affected
350 - 700	Most moderately sensitive/tolerant crops affected	Moderately tolerant crops affected
> 700	Increasing problems across crop tolerance classes	Tolerant crops increasingly affected

Table 2 -- Relative Susceptibility of Crops to Foliar Injury from Saline Sprinkling Waters

Applies when sprinkler irrigation wets crop foliage directly. Tobacco is a special case -- quality is affected by chloride above 25 mg/L.

Sensitive <=175 Almond; Apricot; Citrus; Plum; Grape	Mod. sens. 175-350 Pepper; Potato; Tomato	Mod. tol. 350-700 Barley; Maize; Cucumber; Lucerne; Safflower; Sesame; Sorghum	Tolerant >700 Cauliflower; Cotton; Sugar beet; Sunflower
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Table 3 -- Annual Crops Grouped into Chloride Tolerance Classes (Saturated-soil Extract)

Thresholds reproduced exactly as printed in the source -- not strictly monotonic between middle columns. Treat as a relative ordering, not precise cut-offs; use the mg/L table above for authoritative thresholds. * = less tolerant during emergence/seedling.

Sens. <=350 Strawberry; Bean; Onion; Carrot; Radish; Lettuce; Turnip	Mod.sens. ~425 Pepper; Clover, strawberry; Clover, red; Clover, alsike; Clover, ladino; Corn; Flax; Potato; Sweet Potato; Broad bean; Cabbage; Foxtail, meadow; Celery; Clover, Berseem; Orchardgrass; Sugarcane	Mod.tol. 700-1200 Trefoil, big; Lovegrass; Spinach; Alfalfa; Sesbania*; Cucumber; Tomato; Broccoli; Squash, scallop; Vetch, common; Wildrye, beardless; Wheat; Sudan grass; Wheatgrass, standard crested	Tolerant 400-2100 Beet, red; Fescue, tall; Squash, zucchini; Hardinggrass; Cowpea; Trefoil, narrowleaf bird's-foot; Ryegrass, perennial; Wheat, Durum; Barley (forage)*; Wheat	V.tol. 2450-2800 Sorghum; Bermuda grass; Sugar beet*; Wheatgrass, fairway crested; Cotton; Wheatgrass, tall; Barley*
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Boron

p.35 -- root uptake

mg/L	Effect
<= 0.5	Target range -- prevents toxicity in all but the most sensitive plants
0.5 - 1.0	Very sensitive crops: foliar injury / yield decrease
1.0 - 2.0	Sensitive crops affected
2.0 - 4.0	Moderately sensitive crops affected
4.0 - 6.0	Moderately tolerant crops affected
6.0 - 15.0	Tolerant crops affected

Inorganic Nitrogen

p.119

mg/L	Effect
<= 5	Target range -- low enough not to affect even sensitive crops (grapes, most fruit trees); unlikely to leach to groundwater
5 - 30	Sensitive crops increasingly affected; groundwater contamination risk rises with applied volume
> 30	Most crops affected; severe restrictions on utilisation

Scaling / Corrosion -- Langelier Saturation Index

p.131

Langelier Index	Effect
<= -0.2	Increasing problems with corrosion of metal and concrete
-0.2 to +0.2	Target range -- no major corrosion or scaling problem
> +0.2	Increasing scaling / encrustation of pipes, drippers, openings

Aggressiveness Index (AI)

$AI = pH + \log_{10}(\text{Total Alkalinity} \times \text{Calcium Hardness, both as mg/L CaCO}_3)$ -- formulated for asbestos-cement pipe corrosion.

AI	Water property
> 12	Non-aggressive
10.0 - 11.9	Moderately aggressive
<= 10	Highly aggressive

Ryznar Index (RI)

$RI = 2 \times pH_s - pH_a$ (pH_s = Langelier saturation pH, pH_a = actual pH).

RI	Tendency
< 6.5	Scale-forming tendency
> 6.5	Corrosive tendency

A fourth index (Corrosion Ratio, R) is also given for chloride/sulphate-driven corrosion: $R < 0.1$ indicates general freedom from corrosion in neutral-to-slightly-alkaline oxygenated water.

Suspended Solids & Faecal Coliforms -- Drip Emitter Clogging

p.161 & p.71

Suspended solids (mg/L)	Faecal coliforms (/100mL)	Clogging outcome
<= 50	<= 10,000	Target range -- practically no clogging problems
50 - 100	10,000 - 50,000	Slight to moderate clogging problems / likelihood
> 100	> 50,000	Increasingly severe / likely clogging

Trace Elements & Heavy Metals

All 17 follow the same three-tier pattern: target range -> maximum for fine-textured neutral/alkaline soils -> short-term, site-specific use only. Units mg/L unless noted. Most are explicitly marked tentative in the source, based on comparatively limited data. (t) = tentative guideline.

Element	Target (<=)	Intermediate	Short-term (>)	Notes
Aluminium	5.0	5 - 20	20	
Arsenic (t)	0.1	0.1 - 2.0	2.0	see Crop Yield vs Quality below
Beryllium	0.10	0.10 - 0.5	0.5	
Cadmium (t)	0.01	0.01 - 0.05	0.05	accumulates toward food-chain toxicity
Chromium(VI) (t)	0.10	0.10 - 1.0	1.0	
Cobalt (t)	0.05	0.05 - 5.0	5.0	
Copper (t)	0.2	0.2 - 5.0	5.0	
Fluoride	2.0	2.0 - 15.0	15.0	
Iron	5.0	5.0 - 20.0	20.0	foliage staining risk when wetted
Lead	0.2	0.2 - 2.0	2.0	
Lithium	2.5	--	--	citrus far more sensitive (~0.075 mg/L)
Manganese	0.02	0.02 - 10.0	10.0	
Molybdenum (t)	0.01	0.01 - 0.05	0.05	animal (forage) toxicity, not plant
Nickel (t)	0.20	0.20 - 2.0	2.0	
Selenium (t)	0.02	0.02 - 0.05	0.05	animal (forage) toxicity, not plant
Uranium	0.01	0.01 - 0.10	0.10	
Vanadium (t)	0.10	0.10 - 1.0	1.0	
Zinc (t)	1.0	1.0 - 5.0	5.0	

Arsenic -- Crop Yield vs. Crop Quality (separate norms)

Unlike most trace elements above (one combined column), the source gives Arsenic separate Crop Yield and Crop Quality criteria. Cadmium's source table, by contrast, genuinely uses one combined column -- it is correctly NOT split here.

mg/L	Crop Yield	Crop Quality
<= 0.1	Target range. Nutrient solutions containing 0.5-10 mg/L have been shown to induce arsenic toxicity in some species -- but only a fraction of total soil arsenic is plant-available.	Yield reduction / crop failure are the main effects of arsenic-contaminated soils; arsenic generally does not accumulate in edible plant parts to dangerous levels, though root crops (potatoes, radishes) concentrate it.
0.1 - 2.0	Maximum concentration acceptable for fine-textured, neutral to alkaline soils.	As above -- soil accumulation, not consumer toxicity, remains the limiting concern.
> 2.0	Acceptable for irrigation only over the short term, on a site-specific basis.	As above.

Coverage & sources

All primary Target Water Quality Range tables for all 30 parameters, plus the per-crop supporting tables for SAR/ESP, Chloride, and Salinity, are reproduced here. Two Salinity sub-tables (Grasses & Forage, Ornamentals) pack many species per source cell with no per-item delimiter -- reproduced as reconstructed text lists rather than risk a wrong species boundary. Source: South African Water Quality Guidelines, Volume 4: Agricultural Water Use -- Irrigation, Department of Water Affairs & Forestry, 2nd Edition, 1996.

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