Water-efficient vegetable washing and cooling systems for commercial market gardeners

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Horticulture in Australia

The scale of the industry normalised to a per capita of population basis

Annual farm-gate value:	$200 per person
Area planted:	100 m^2 per person
Water consumption:	100,000 L per person

What annuals are grown?

Commodity planted	Approximate areas planted km^2
Beans and peas	170
Brassicas	145
Peppers	16
Potatoes	440
Sweet corn	53
Tomatoes	80

What perennials are grown?

Commodity	Notional sizes of areas planted km^2
Asparagus	21
Bananas	121
Berry fruit	16
Citrus	300
Pome fruit	200
Stone fruit	27

Water usage by Australian horticulture

Total usage of water in Australia:	20,000GL
Usage by agriculture:	14,000GL
Vegetables:	634GL
Fruit:	704GL
Grapevines:	649GL

Projected water usage by Australian horticulture

Projected water use in 2020 is:

Vegetables:	1300GL
Fruit:	1300GL

The predicted growth rate in water consumption is 3% pa.

Value of horticultural produce per ML

Commodity	Value ($) per ML
Fruit	1460
Vegetables	1760
Grapevine	945
Cotton	613
Pasture	289
Rice	189

Focus on Victoria

Value of fruits and vegetables:	$417 million
Water consumed	
Vegetables:	122GL
Fruit:	172GL
Grapevines:	242GL
Amount of water recycled:	22.4GL

Victoria lags when it comes to re-cycling water for horticulture

State	Water re-cycled GL	Water re-cycled %
SA	10.4	10.3
QLD	33.6	10.1
WA	10.0	10.0
NSW	39.7	6.1
VIC	22.5	5.4

Fruit and vegetables need to be cooled after harvest

Fruits and vegetables begin to deteriorate as soon as they are harvested.

They lose their firmness, lose their flavour and they can become infected with bacteria, fungi and viruses.

The rate of deterioration of fruits and vegetables depends strongly on temperature

Broccoli:

Temperature (°C):	0	5	10	15	20
Shelf-life (days):	42	25	11	5	3

Shelf-life at 35 °C is less than 12 hours.

The rate of deterioration of fruits and vegetables depends strongly on temperature

Carrots:

Temperature (°C):	0	5	10	15	20
Shelf-life (days):	32	22	16	11	8

An answer is to cool vegetables in a hydrocooler

Vegetables are drenched with refrigerated water

There are problems with many hydrocoolers

The water used to cool the produce is not potable – some use untreated river water and just recycle it over the produce.

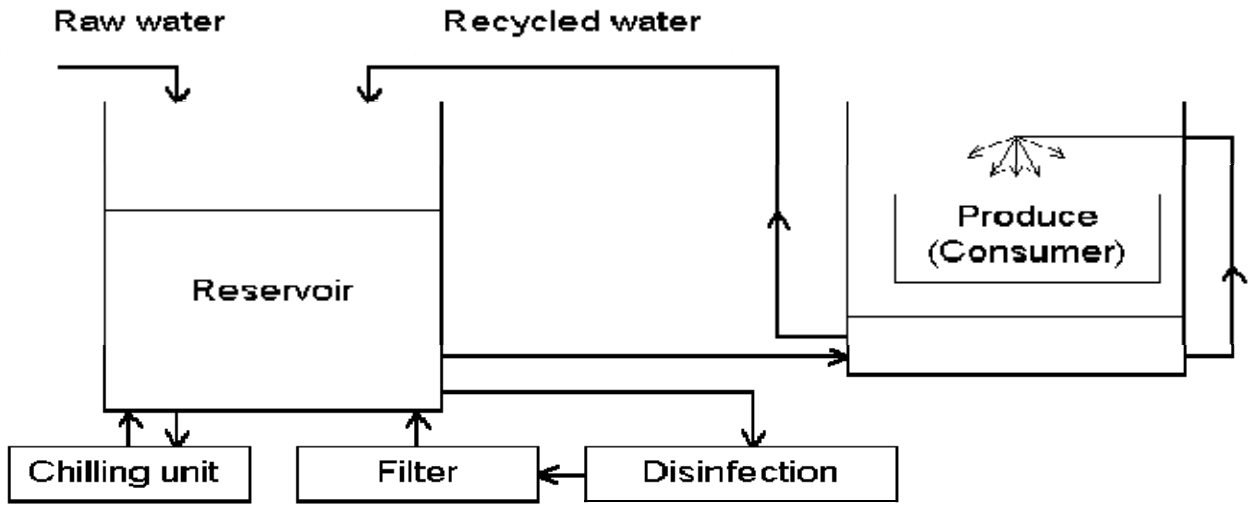
Perhaps half of all hydrocoolers manufactured in Australia do not have any system of treating recycled water.

More problems with hydrocoolers

Little thought is given to reducing heat losses

In some cases water is used once and then discharged

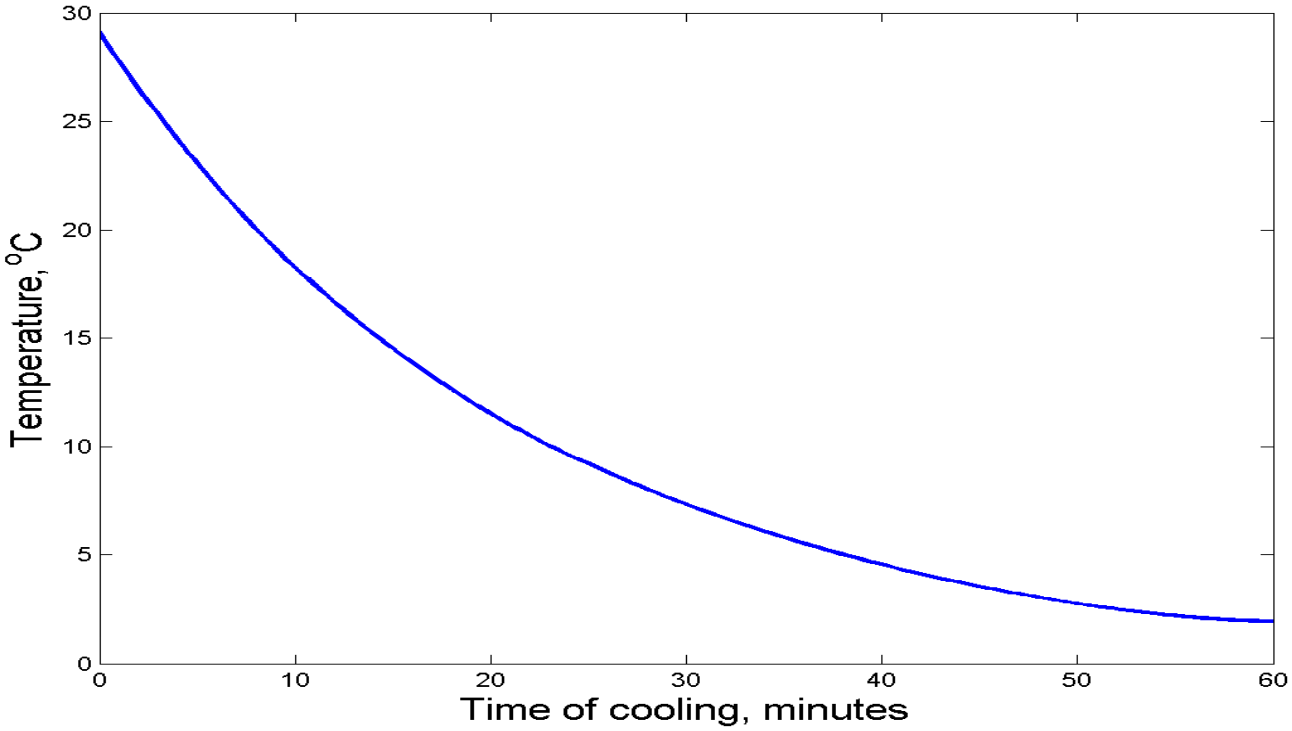
Schematic of a hydrocooling system viewed as a water treatment plant.



The design brief

- Cool 6 tonnes per hour of horticultural produce from 29ºC to 12ºC, or 4 tonnes per hour from 29ºC to 6ºC.
- Be designed so that boxes of produce are to be loaded into and out of the hydrocooler by means of a fork lift truck.
- Be transportable from one horticultural growing region to another. In this way it may be used in Queensland to cool broccoli in early summer, say, and then be transported to Victoria later in the year.
- Have a very low water and energy consumption.

The rate of cooling of broccoli

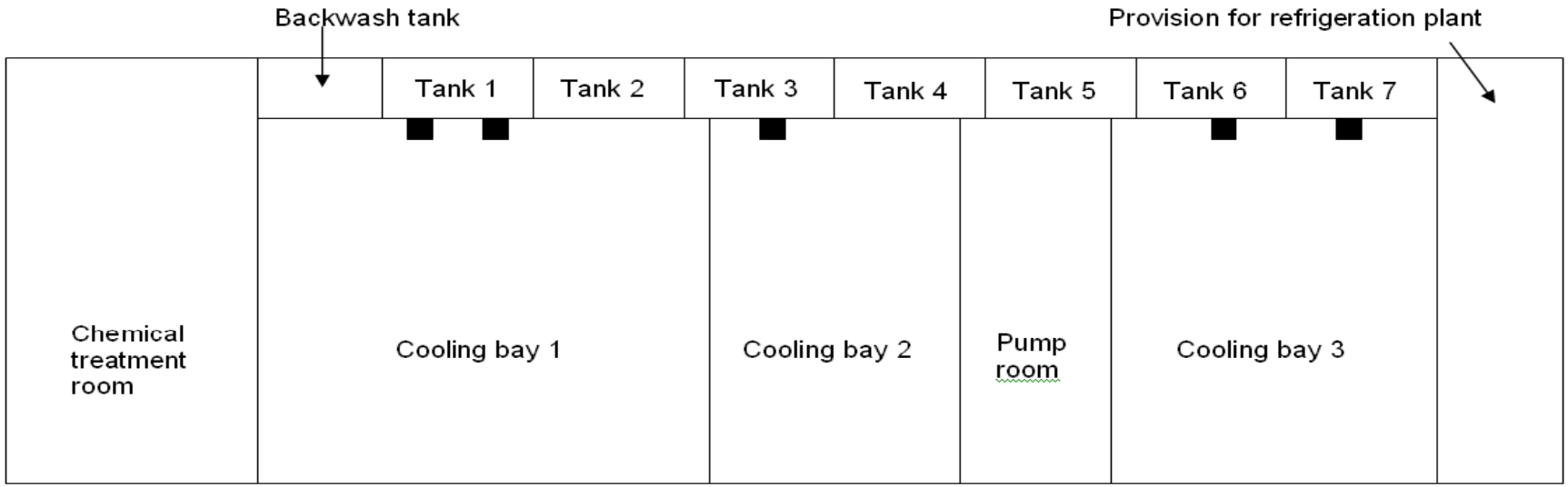


Physical realisation by Wobelea Pty Ltd, Pakenham

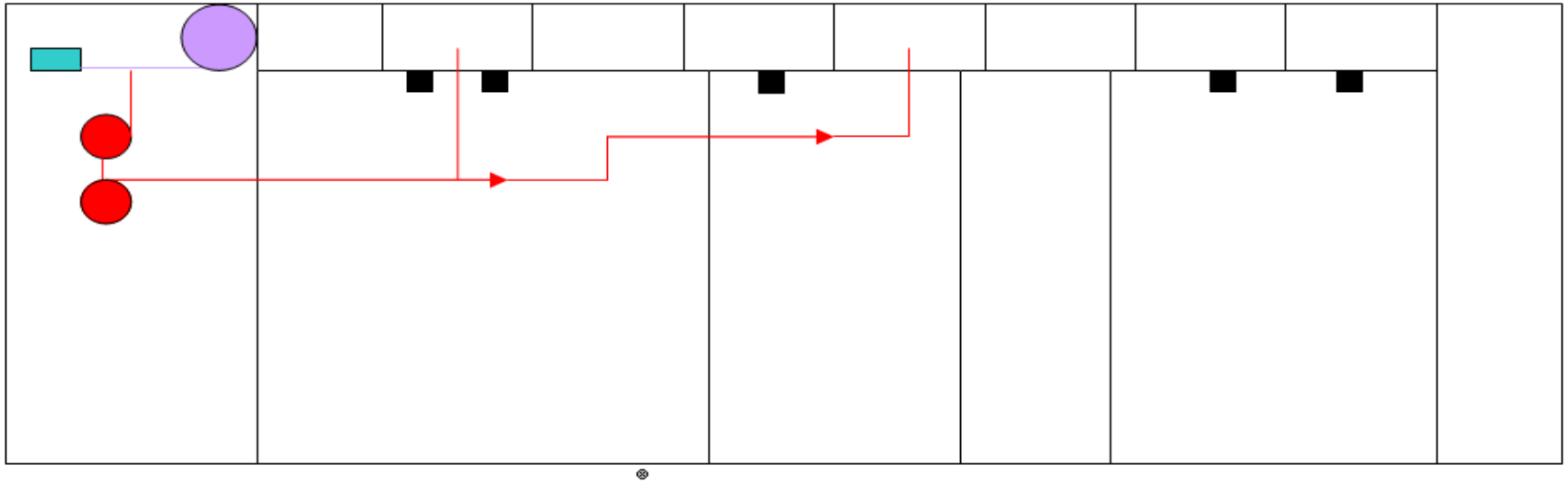
Overall dimensions of the Smart Water Fund hydrocooler

	Length, mm	Width, mm	Height, mm
External	6050	2420	2590
Internal	5600	2200	2200
Tare	3050 kg		
Tare with dry sand	6050 kg		

The overall layout of the hydrocooler



The chemical treatment circuit

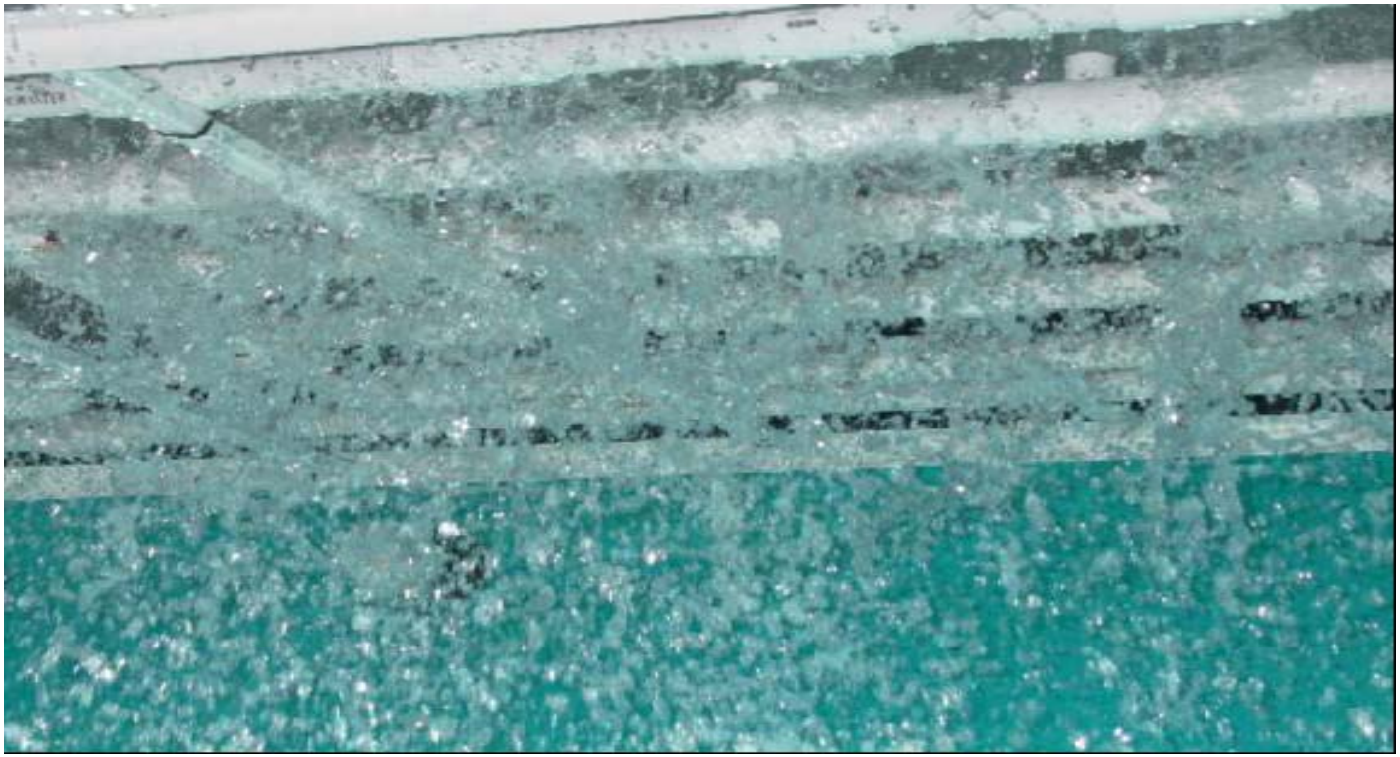


Realisation of the chemical treatment system

The water distribution system

The water distribution system

The water distribution system in action



The SWF hydrocooler in action

The water chiller

Outcomes of the SWF project

A large scale, transportable hydrocooler has been developed. It is designed to cool 6 tonnes per hour of broccoli from 30ºC to 12ºC per hour.

Outcomes of the SWF project

The water in the hydrocooler is recirculated and the water consumption is estimated to be 35 litres per tonne of round fruit such as apples and 75 litres per tonne of broccoli. If the water were not recirculated, as was the case when the project was initiated, the water consumption would be 60,000 litres per tonne of produce cooled.

Outcomes of the SWF project

The electrical running cost is estimated to be 20 kWh and 16 kWh per tonne of produce when the throughput is 4 tonnes per hour and 6 tonnes per hour respectively. If the water were not recirculated the running cost would be about 300kW per tonne. This may be regarded as being infeasible.

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