Smart Water Fund

# Final Report

## The Collection, Treatment and Reuse of Nursery Runoff Water

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**With the support of the Smart Water Fund**

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City West Water
Melbourne Water
South East Water
Yarra Valley Water
Department of Sustainability and Environment

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## Executive Summary

This report provides an evaluation of the history, current status, performance indicators and future directions of the project.

The success of this project is measured by the savings in water consumption achieved by the augmentation to overall supply, the environmental benefits and the level of interest shown by the community.

Although a lot of the evidence of the success of this project is somewhat anecdotal, there is no doubt the project has delivered significant financial savings to the company even over the short period it has been in operation.

The report finds that further detailed scientific study, data collection, analysis and evaluation, far in excess of anything proposed to date, would be a desirable objective for the future. This would make an excellent project for a post-graduate student.

Economic circumstances over the last couple of years have precluded the full allocation of resources in the collection of data as originally proposed. The project has been negatively impacted upon by the fact that of the last four years, three of them have been in severe drought meaning that the project never fully reached its designed operating levels.

The project is saving ERA at least $20,000 annually in water costs and on the basis alone it has already paid for itself.

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## Background

ERA Nurseries located its main nursery operation to a 4 ha ‘greenfields’ site at South Boundary Road, Hamilton in the winter of 2004. Building works commenced in June 2004 and the site works for the nursery proper were commenced in the spring of that year once these areas had dried sufficiently to allow access by earthmoving equipment.

It was always realised that the Hamilton area would one day be subject to drought conditions and that limitations with respect to the use of potable town water for commercial irrigation may become limited or restricted. A water collection, treatment and storage scheme was therefore incorporated into the initial design and budget for the construction of the new nursery facility.

The site lent itself to water run-off collection as it is gently sloping and has an abundance of clay subsoils for the construction of surface water storages. As the nursery areas were formed, an underground network of collection drains were installed.

Most of the major works associated with the scheme were completed by the end of 2005 and prior the uptake of the relationship with the Smart Water Fund.

The prediction of drought was well-founded as the years of 2006, 2007 and 2008 were variously years of below average rainfall and the local water authority did impose severe water restrictions. By 2009, the rainfall reached the long term average meaning that the scheme could not be fully evaluated until then.

ERA Nurseries have had a major commitment to the production of forestry seedlings over the last decade or so. The well publicised failure of Managed Investment Schemes promoted by companies like Timbercorp and Great Southern has impacted heavily on the Nursery. Prior to that there were a couple of lesser known company failures. ERA Nurseries suffered major financial losses arising from these failures.

This has meant that that all non-essential expenditure has been cut or reduced and this has had a negative effect on the provision of resources to undertake monitoring on the project to levels we would have desired.

Despite a downturn in the forestry sector of the business affecting overall production levels, ERA is nevertheless heavily dependent on the water recycling scheme to provide the majority of the overall water requirement.

## Introduction

ERA Nurseries operate a large scale seedling production nursery in Hamilton and is one of the largest uses of water in the region.

The company focussed on the issues of water collection and recycling during the design and construction phases. The project incorporated an elaborate system of sub-surface drains to collect irrigation run-off and rainfall. The system includes a series of treatment and storage structures and incorporates a biological reed-bed slow filtration nutrient removal phase together with post-storage Iodine treatment prior to reuse. The innovations mainly lie in the various components of the overall system and the manner in which they interact to provide very high-quality recycled water resource.

The overall system includes the following components (in sequence);

- *Collection and sub surface drain network*
- *Surge diversion*
- *Primary storage (1ML)*
- *Reed bed biological nutrient removal*
- *Secondary storage (5ML)*
- *Automated pumping system*
- *Header storage (45KL)*
- *Iodine treatment plant (automated)*
- *Reuse for irrigation (4 litres/sec)*

## Objectives/Goals

Over the years a number of water recycling issues in and around Hamilton have been canvassed. The most prominent of these was the recycling and reticulation of treated municipal effluent and industrial wastewater. Studies were undertaken but we believe that the studies proved to be negative. It was therefore considered not to be feasible in either economic terms or water quality criteria.

Even with these external initiatives, the principle objective has always been to collect and recycle as much water as possible from the site that ERA occupies. This is to ensure that the minimum quantity of reticulated water is used and also to stay within the limits allowed under the private water agreement we have with the supplier, Wannon Water.

ERA believes in an ethical sense that treated and filtered drinking quality water should not be routinely used for irrigation and we have therefore invested heavily to pursue the outcome inherent in the water recycling system.

Although there are significant financial savings involved by using mains water the real driver is that fact we could not continue in business without having it given that our allocation of mains water is limited by contract to 4.8 Ml.

The consumption of water over the full year of 2008/09 was estimated at approximately 15 Ml of which well over two thirds was supplied from our recycling system. (This total water use figure was down from 18Ml in 2005-06 due to reduced activity.)

Our goal is to further reduce the dependence on mains water however this goal will be almost entirely dependent on prevailing weather conditions and receiving long term average rainfall or greater.

Overall this project aims to;

1. Significantly off-set the use of main water supplies. The degree of augmentation will largely depend on prevailing weather conditions in particular rainfall.

2. Greatly improve the quality of recycled irrigation water and rainfall run-off water using biological reed-bed filtration and nutrient removal systems and automated iodine water sanitation.

3. Collect water samples at regular intervals and measure critical chemical and physical water quality parameters to determine the efficacy of the process over time

4. Prepare information packages including collated data sets and associated descriptive information and make this available to interested parties through a variety of means including a dedicated section of the ERA website.

## Project Overview

The water recycling project consists of a number of identifiable components as described below;

The water collection network

There are some 2 km of cut-off drains and associated pipework running through the entire nursery property. All rainfall and irrigation runoff is collected and channelled to the primary collection dam. Earth bunding has been constructed to channel water to the primary dam in the event of an extreme rainfall event and in circumstances where the subsurface drainage system is unable to cope with stormwater volumes.

In addition to the ground works, all rainfall collected from rooves and hard paved areas is diverted to the system. More recently, water falling on adjacent roadways and public areas has been diverted to the system via some new pipework that has been installed under South Boundary Road near the main entrance to the nursery

The cut off drains consist of 900mm slotted PVC pipe located in a 300mm x300mm trench filled with 20mm screenings.

The primary collection dam

All water from all sources enters this dam in the first instance. The principle purpose of this 1 Ml structure is to act as temporary storage for incoming water and to allow any particulate matter and gross solids to percolate out. Any algal blooms that may occur due to the high nutrient load will be confined to this area and treated accordingly. Also, by keeping the level down it has been possible to have this structure act as a buffer in the event of a large inflow in a short space of time.

The surge diverter

This surge diverter was constructed in late 2006. It is a concrete structure located near the inflow point on the primary collection dam. Its purpose is to divert stormwater inflows through a large diameter pipe in the event of the system being subject to inflows in excess of the capabilities of the overall system.

In the early days we experienced a couple of severe rain events which came close to destroying the earth banks surrounding the reed bed.

Since the surge diverter has been installed, no such threats have arisen.

The reed bed filtration and nutrient removal system

This structure is located between the primary collection dam and the storage dam. Before any collected water can enter the storage dam it must pass through the reed bed system.

This clay lined structure is approximately 34m x 11m in area and is filled with fine 7mm gravel to a depth of 500mm.The filtration media is comprised of 65% gravel and 45% water when inundated. Around 84 kl of water is in the treatment zone at any one time and whilst in residence the reeds actively take up nutrients and other pollutants from the water.

An elaborate array of pipework means that all water entering the system is uniformly distributed. Similarly, water leaving the system to storage is also evenly distributed. Water levels in the reed bed can be easily adjusted to allow for maintenance.

The filtration system was planted with common reed in 2008 and over the last 2 years it has become well established.

Natural flows through the system in summer are reduced due to low rainfall compared to the other seasons of the year. In this instance water is regularly pumped from the primary collection dam into the reed bed using a transfer pump with a capacity of 1.8 cubic metres a minute.

Storage dam

The storage dam is a large structure originally of approximately 5 Ml capacity. It was extended in April 2007 to approximately 6 Ml.

Because of favourable sub soils, the dam has been excavated to significant depth so that overall surface area to water storage volume is relatively small thus minimising losses through evaporation.

The routine use of anti evaporation film has further reduced losses through evaporation.

Iodine water treatment system

An iodine water treatment system has been installed as a final treatment process.

## Literature Review

At the time this project was being planned and designed there was not a lot of literature around that was specific to the specific application. There had been some initial work undertaken by the University of NSW and published in an abbreviated form by the Nursery and Garden Industry Australia and titled ‘Designing a nursery reed bed’

A copy of the working papers was obtained from the Nursery Industry Association and from then on the principles were adapted to this specific application.

The calculations to determine the sizing of the project were all undertaken in-house and included monthly rainfall data, evaporation, estimates of inflow, estimates of water usage etc. These calculations were used to develop a model which has proven in 2009/10 to be quite accurate.

## Findings/Results/Outcomes

The scheme has been operational for 4 full years to date. Of those, the first 3 years were variously drought affected. Only 2009 was near to average rainfall with most rain falling during the autumn, winter and spring periods.

Unlike each of the preceding three years, 2009 did not receive a major summer tropical rainfall event which tends to skew the data and in effect exacerbate actual drought conditions.

The capability and capacity of the project could not be fully assessed until 2009/10 and this was the first time the system had filled to capacity at the end of winter.

Therefore the level of augmentation provided over the irrigation season of October 2009 until late March 2010 will be a fair indication of what can be expected in an 'average' rainfall scenario.

During the drought years of 2006 – 2008 (incl) the nursery had to use its full 4.8 Ml mains water allocation to get through the year. Admittedly, the overall nursery crop in 2006/7 and 2007/8 was larger than both 2008/9 and 2009/10 and this would have had an effect and the searing summer conditions of 2008/9 would also have resulted in higher water consumption rates.

By contrast, it appears at this stage that in 2009/10 we will probably use around 1 Ml of mains water meaning that well over 90% of water used in the nursery was supplied by the recycling system.

Water consumption from the mains is metered and therefore exact usage data is readily available.

The water provided by the recycling scheme is based on estimates. Whilst it would be simple to fit a water meter to the off take piping, we have been unable to locate a suitable and affordable metering device. This is despite extensive enquiries to plumbing firms, water authorities and suppliers.

A significant observation is that almost all of the inflow into the system comes from rainfall and very little from irrigation run-off. The nursery is only irrigated in the warmer months of the year and even then irrigation loading rates are kept to a minimum to avoid unnecessary wastage. Losses to evaporation and evapotranspiration keep the lactates that reach the primary dam to a minimum.

## Risk Management

Salinity

The system water recycling and storage system is essentially a closed system. Over the last 4 years there has only been one brief period in late winter 2009 where the storage dam overflowed for any length of time thus flushing the system (albeit in a relatively minor way).

There has not been an increase in salinity over the full period the project has been operational yet it would be logical to expect that salinity levels would increase over a period of time in a closed system.

Random salinity sampling and measurement of the storage dam over the last 4 year period has consistently yielded EC values between 0.4 and 0.5 (dS/m). By comparison, mains (potable) water measured between 0.4 and 0.7 during the same period.

**Table 1. Suggested criteria for irrigation water use based upon conductivity.**

| **Classes of water** | **Electrical Conductivity** |
|---|---|
| | (dS/m)* |
| Class 1, Excellent | ≤0.25 |
| Class 2, Good | 0.25 - 0.75 |
| Class 3, Permissible | 0.76 - 2.00 |
| Class 4, Doubtful | 2.01 - 3.00 |
| Class 5, Unsuitable | ≥3.00 |

Salinity levels are very low as can be seen by comparing salinity values to the above commonly cited table. Salinity is the main water quality parameter that could potentially pose a risk. It is not known why the body of water held in the storage dam is not increasing in salinity over time.

The nutrients applied through fertigation are in a soluble form and are therefore quite mobile. The main nutrient applied is N with lesser amounts of K & P. Nitrogen is applied in the form of calcium nitrate so therefore any of the residues would be mainly in the form of calcium salts which are relatively innocuous compared to say sodium salts. Even if conductivity levels were higher it may well be that any deleterious effects may not eventuate arising from the use of calcium nitrate. It may well be argued that calcium is essential for healthy plant growth and therefore its application is beneficial.

Special care is taken to avoid spillages of any sort anywhere on the property in order to protect the integrity of the recycled water resource.

In addition, ERA maintains a minimal chemical spraying regime. The use of fungicides for instance, is generally avoided altogether in favour of pre-emptive disinfection treatments.

Herbicide is limited to a couple of products and the use of persistent pre-emergent chemicals herbicides is not permitted. The use of insecticide is only undertaken rarely and only when absolutely necessary and even then only in a minimal way.

Algal Blooms

Fertiliser is applied through the sprinklers (fertigation) during the warmer months of the year when the nursery crop is actively growing. A portion of this is leached out from the plant root ball and eventually ends up in the primary dam.

As this leachate is highly concentrated with the major nutrients including phosphorous, it is not surprising that algal blooms occur. This is accentuated in summer with warm water temperatures and consistently high levels of sunlight.

These blooms occur each summer in the primary part of the system resulting in rapidly growing blooms which can quickly block pipes and create serious operational difficulties.

We have been routinely treating these outbreaks in the very early stages with recommended rates of chelated copper (Cupricide). These treatments are highly effective producing rapid results.

Water authorities use this product in the major reservoirs where algae may threaten municipal water storages. Chelated copper remains suspended in the water column and instantly kills algae on contact. Because the dosing levels are so low there is no discernable downstream phtyotoxic affect arising from copper toxicity.

It is noted that there has been no algae observed at any time in the main storage dam thus providing evidence that the reed bed has been effective in removing the nutrients that are essential for the formation of algal blooms.

The development of dense terrestrial plantings is intended to provide a windbreak to reduce air flow across the water surface to reduce evaporation losses. It would appear that that strategy is already quite effective.

The shelter that these plantings provide has attracted large numbers of birds. Flocks of corellas often visit the site and there are also large numbers of water birds such as ducks, cormorants, swans and other animals that have taken up residence. Whilst this is pleasing to see the downside is that the large numbers of birds will produce large amounts of excreta which will in time be the source of unwanted algal growth.

A large flock of corellas were encouraged to move on 18 months ago following the erection of a swaying 6 metre high PVC pipe with a plastic eagle mounted on the top.

Evaporation losses

The surface evaporation losses can amount to the equivalent of around 1800mm of water from storages each year. Apart from the huge loss of water, evaporation can of course increase the concentration of salts.

There have been multiple strategies developed to reduce evaporation. The first of these is the extensive windbreak planting referred to earlier. These comprise local species and are densely planted and will be effective in reducing erosion of earth banks. Growth development has been relatively slow given that these clay lined banks have been heavily compacted during there construction.

The second strategy looked at involved covering the storages with an impermeable membrane however this was deemed not to be a realistic option given the cost and the wide fluctuation in water levels.

We use an anti-evaporation film (Aquatain) which the manufacturers claim can reduce evaporation losses by >70%. We apply this weekly in very hot weather otherwise every 2 weeks and not at all in winter. It is a very fine polymer which spreads across the surface rapidly providing a very thin (a molecule or two) film which largely prevents contact between air and water thus reducing evaporation losses.

## Return on Investment

There is no doubt that the investment in the water recycling scheme has been essential for the continuation of the ERA nursery business. In fact without it, it could be argued that ERA may not have been able to continue at the levels required particularly during the drought years where strict water restrictions were applied. No extra water allocations were available during much of that period.

ERA estimates that the cost of the system was $77,000 excluding the cost of the Iodine treatment plant and pre-irrigation storage tanks.

ERA purchased a water allocation from Glenelg Water (Now Wannon Water) in 2004. The allocation was for 4.8 Ml per year and with a one-off cost of $45,000 which included what was described as a ‘development charge’. Had the entire water requirement been purchased at the time it would have cost ERA (by extrapolation) $168,750 or more than twice the capital cost of the water recycling scheme.

Water was charged for at the rate of $0.91c/kl in 2005. The current price (2010) for water is $1.92c/kl. The current annual savings on water consumption is therefore at least $19,200 (10 Ml) but more likely to be around $30,000 (15 Ml).

Wannon Water is commissioning major capital works in mid 2010. The centrepiece of these works is the Rocklands – Hamilton pipeline. Wannon Water has stated that the cost of these capital works will be reflected in water prices in the future and these costs will be in addition to CPI increases.

These predictions further vindicate the decision to develop the water recycling project.

## Publicity and Enquiries

The project has received considerable publicity in the local print media over the last 5 years and copies of the articles have been forwarded to Smartwater as they appeared.

ERA maintains information on the projection its web site and will continue to do so. It is intended to post an edited version of this final report on the web site subject to the approval of Smartwater.

There have been many individuals and groups visit the nursery over the last 5 years and inspect the project including;

- School groups (.e.g. Monivae College)
- Conference delegates attending conferences and seminars in the Hamilton area (e.g. Rural Women's Association)
- Community groups (e.g. the Hamilton Vintage Car Club)
- Service clubs (e.g. Hamilton North Rotary)
- Rural Show Organisers (e.g. Hamilton Sheepvention)
- Professional Organisations (e.g. Nursery Industry Association of Victoria)
- Media (e.g. Hamilton Spectator. ABC television)
- Nursery Industry (e.g. Nurseries from throughout Victoria and interstate)
- Industry – other (e.g. Hamilton Turf)

In addition there have been many phone enquiries arising from interested parties accessing the web site.

ERA will continue to maintain and 'open door' policy for anyone interested in inspecting the project and will provide information and advice when and where it is appropriate

## Photo Album


November 2004. *Excavation of the storage structure was a major task requiring large amounts of material being carted from the site.*


November 2004. *Due to site constraints the storages have been constructed to be as deep as possible with the minimum surface area. There was abundant clay on site to line the structure.*

November 2004*. Irrigation and drainage/collection networks being fabricated and installed*

March 2006. *Work being undertaken on the reed bed filtration structure*

January 2007. *A 90 mm in 24 hours rainfall event caused significant damage to the partially completed earth structures*

*This and other similar events vindicated the decision to construct a surge diversion component to the system.*

February 2007. *Extensive rock walling and beaching in the storage and reed bed areas is being placed to reduce wave action and rain impact erosion to the earth structures.*

March 2007. *Extensive pipe networks are designed to ensure that the highest level of flow uniformity was achieved through the gravel media.*

*Installing the inflow manifold to the reed filtration structure*


February 2008. *The reed bed has been planted with rhizomes of common reed and inundated to allow the subsurface portions of the plant to develop and produce new emergent shoots.*

March 2010. *The same aspect showing considerable development of the reed bed. Also note the development of the landscaping elements in the background. It is essential to keep these aquatic plants inundated at all times.*

February 2007. *Storage dam showing pump off-take floatation structure*

*Surge diverter showing spillway which is set at an exact level to prevent stormwater flowing over earth banks downstream.*


March 2010. *Main storage dam towards the end of the irrigation season. A minimum water level is maintained to ensure the integrity of the clay lining is maintained*


March 2010. *Extensive plantings of indigenous species reduces bank erosion, reduces wind flow over the water and provides habitat for a wide range of bird and animal species*.