A social appraisal of the South Australian Virginia Pipeline Scheme: Five years' experience

20 May 2005

June S. Marks and Katherine F. Boon

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Researcher contact details

Dr. June S. Marks
Department of Sociology
Flinders University of South Australia
GPO Box 2100
Adelaide SA 5001

Phone: 08 8201 2628
Email: june.marks@flinders.edu.au

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Dr Maria Zadoroznyj
Department of Sociology
Flinders University Adelaide

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EXECUTIVE SUMMARY

1 Introduction

The Virginia Pipeline Scheme (VPS) is the largest scheme of its type in Australia (SA Water 2005; EarthTech 2005) and was established in 1999 to deliver unrestricted Class A reclaimed water to irrigators on the Northern Adelaide Plains (NAP) in South Australia. The purpose of this research was to investigate and report on the various stakeholder perceptions of reclaimed water used in the VPS from its development and operation up to the present. The results will feed back into a larger study on the use of reclaimed effluent water in Australian Horticulture (Boland 2004a; Boland 2004b) and the communications project Coordinator for Recycled Water Development Horticulture (CRWDH, 2005). The objectives of the study were to:

(i) review the key issues associated with a scheme that has been running for 5 years and learn from these in the application to other schemes
(ii) understand the current communication deficiencies with the view to assessing the impact of current activities in the future.

2 Literature review

The review draws from the social sciences literature that relates to the concept of reclaimed water for the irrigation of food crops; there is little published research that directly relates to the practice. Both 'top-down' and 'bottom-up' processes are required for the development of trust, being the structural shapers and the characteristics of the social actors (Szompka 1999). The literature on the characteristics of risks and adoption of new technology help explain the level of acceptance of reclaimed water. Effective public consultation will involve multiple methods and sources to actively engage the community. Further, a reconsideration of power relations is required to achieve sustainable (triple bottom line) outcomes.

3 Design and methodology

The research brief was to investigate and report on stakeholder perceptions of reclaimed water in relation to the VPS. The design, management, and ethics submission and approval were undertaken prior to the commencement of data collection in October 2004. An embedded case-study design was used. Information from the participants was gathered using a semi-structured interview approach either in person or over the phone. The interviews were audio taped with the permission of participants or notes were taken, and then transcribed for data analysis. The interview response rate was exceptional, with only four people declining to participate. Some difficulty was experienced in obtaining documentation on previous projects in the region. The findings reported are those that were obtained from interviews with participants and are based on their understandings and perceptions. Some statements may not be factually correct.

4 Findings

4.1 Demographics

A total of 75 stakeholders contributed to the research, these include: 36 growers; 2 Quality Assurance advisers; 2 major retailers, 9 wholesalers, 3 regulators, 3 water providers, 3 water policy/strategy agencies; 12 horticulture/irrigation advisers and researchers; 6 members of the Virginia Horticulture Centre (VHC) Board; 6 Industry Associations; and 6 Industry associated businesses. Some of the 75 respondents have multiple roles across the various groups.

The growers interviewed were from various farming practices (13 Broadacre, 12 glasshouse, 6 perennial and 5 perennial-glasshouse growers) and cultural backgrounds (Italian, Greek, Vietnamese, Cambodian and Anglo-Saxon). The types of crops grown vary from heavy vegetables to salad through to permanent crops.

There are currently around 285 connections to the VPS involving 230 customers, approximately 50% of these would be smaller businesses taking under 25 ML/a; with the average of the broadacre grower allocations being around 100 ML/a.

4.2 Previous social research in relation to the VPS

Previous research relating to the VPS is as listed below:

- Identification of the technical, scientific and social barriers to the adoption of reclaimed water on the NAP relating to the production of horticulture crops (Kelly and Hollow 2000). Generally, broadacre growers believed that the reclaimed water would be safe and glasshouse growers were not sure; growers were concerned with issues surrounding salinity, sodicity, the water table, biology, heavy metals, produce quality, effects on the market and changes to fertiliser applications.
- National study on the adoption of reclaimed water by Australian horticulturists (Bewsell & Kaine 2004). It is reported that growers found no need to change their management substantially because the water was as good or better than other sources (2004:1).
- Study on the position of the Australian horticultural industry with respect to reclaimed water (Hamilton et al 2005:204) concluded that a number of issues need to be resolved.
- A report on the acceptance of reclaimed water on the NAP (Kelly and Stevens 2001) found that growers were concerned about the repercussions of selling produce due to the algae growth in their reclaimed water on-farm storage facilities "despite the community, grower and wholesaler (buyer) education undertaken prior to the commissioning of the VPS" (2001:3).

4.3 Scheme establishment

Several factors lead to the establishment of the VPS including:

- The depleting groundwater resources on the NAP causing a 'cone of depression'.
- The Environment Protection Authority (EPA) ruled that SA Water needed to reduce nitrogen discharged to Gulf St Vincent from the Bolivar plant (Marks et al 1998; Taylor et al 1995:i).
- The current irrigators were looking for an alternative water source to the then used Class D effluent and to supplement bore water.
- It was also seen as an opportunity to expand horticulture production within the region.

Funding was obtained from a Federal grant ($10.8 million Euratech 2004; Marks et al 1998) through the Better Cities program and Multi Function Polis (MFP); the State Government through SA Water ($6.7 million SA Water 2005); and the private sector via Water Reticulation Systems Virginia (WRSV). The project involves over 100 km of pipeline at a cost of $22 million (SA Water 2005) and a $30 million Dissolved Air Flotation and Filtration (DAFF) plant to achieve Class A quality water (SA Water 2005). The scheme was implemented under a Build Own Operate and Transfer (BOOT) system where ownership transfers back to the SA government from WRSV after 20 years, the term of the BOOT contract.

4.4 Communication and information

Growers became aware of the scheme from other people, attending meetings, field excursions, the media, and from the Virginia Irrigation Association (VIA). The Department of Health communicated the safety aspects of produce grown with reclaimed water to retailers and wholesalers. A crisis management team met as a matter of urgency to address rumours or negative feedback. Growers generally thought that the

meetings relating to the scheme were informative, although some expressed that they were offered more than what they received.

Various published sources of information circulated on the VPS and reclaimed water include: leaflets and brochures; photocopy of overheads outlining the water quality and responsible use; ReWater quarterly newsletter; and The "Grower Manual" (Kelly et al 2001). The Grower Manual, which was delivered with a series of workshops, was noted as being the most recognised publication. Growers do not commonly access ongoing information, and other advisers and managers confirm this. However, they had attended a range of courses relating to and excluding reclaimed water through the VHC or a Government Department. Particular information relating to water quality was obtained from WRSV.

Wholesalers are not in receipt of explanatory or updated information but Quality Assurance (QA) advisers would access additional information if a problem arose. Retailers relied on their QA people – managers, advisers and auditors – to keep abreast of all issues relating to quality.

Seven growers referred to the service provided by WRSV (managers of the delivery of reclaimed water and maintaining the VPS) and four are very satisfied. The dissatisfaction expressed by three growers relates to communication.

The biggest impediment to the uptake of information was seen to be available time. Advisers and growers also suggest a lack of trust in government. Another factor relates to the cultural capital of growers who were raised in a school system based on the traditional top-down transfer of information. Growers and advisers also identified language as a barrier to the uptake of information and understanding of contract conditions.

4.5 Reasons for accessing VPS

Reasons growers gave for connecting to the VPS included: to access a greater volume of water (mostly broadacre growers); additional source to replace the existing 'channel water' or to make use of land with no water source; security of supply that allowed expansion; and a cheaper option to mains water.

The main reason given for those who were not connected was because they could not access the pipeline and the fairness of access was questioned. The reasons for them wanting to connect were similar to those who were already connected although they held some reservations relating to the costs and volume of water. The reasons given for those growers who did not want to connect include: they did not need the water, bore water is cheaper, salt levels are too high, or it was difficult to estimate future requirements.

4.6 Water quality

Public health

Growers were initially concerned how irrigating with reclaimed sewage effluent would affect their markets. On the farm they had reported problems associated with algae in the first 12 months, and water not being delivered when it did not meet the water quality standards. The VHC coordinated a group to develop a risk management strategy when the pipes were being laid to address negative perceptions associated with the use of water sourced from sewage effluent; this turned out to be a non-issue.

Of the growers interviewed that were connected to the VPS, 80% commented on water quality. Nearly half of these are satisfied with the overall quality. They compared produce grown with reclaimed water to other sources and confirmed that there is no difference. However, others are concerned about the effects on produce. There were some concerns relating to 'chemical' elements in the water, nutrient levels, and

some references to people drinking the water. For most growers the focus was on salinity. The quality of Class A reclaimed water in relation to public health is generally accepted as meeting the standards set by the regulators.

Wholesalers do not discriminate between produce grown with reclaimed water or any other source, however, there is a degree of uncertainty, some reticence and concern expressed in relation to potential delayed effects on public health.

Two major retailers were approached and did not appear to have any concerns relating to reclaimed water as long as the providers demonstrated the water met quality guidelines.

QA assessors were initially concerned about reclaimed water and this resulted in a thorough-going scrutiny of the risks involved, which identified that reclaimed water is not singled out as a source of concern as the risk assessment is the same for all water sources, and growers are expected to test water once a year through their QA programme. The earlier issued 'DAFF' or VPS guidelines (prior to the Grower Manual becoming available) are still used as a checklist when the assessor goes on farm visits. However, QA auditing groups are now incorporating aspects of reclaimed water into their training courses. Food Safety Australia will shortly be publishing a document to cover this information.

Salinity

Growers are guaranteed water quality of <1500 mg/L TDS (≈ 2340 μS/cm EC), negotiated with growers during the development of the scheme. Salt levels or salinity was mentioned by three quarters of the growers connected to reclaimed water. Positive comments relating to the effects of reclaimed water on crops were as follows: the salt makes the fruit taste better but it does not "look as good"; two wholesalers agree that Virginia produce tastes better than Melbourne imports; and that salt levels in the water are usually consistent. Additionally, there are a few reports of difficulty growing cucumbers and tomatoes and another referred to possible effects on a perennial crop.

Growers, advisers and wholesalers claim that it is not reclaimed water that affects crops but the fertiliser programme. United Water and Adelaide University are currently undertaking a project investigating how to reduce salinity levels in reclaimed water (Heidenreich 2004).

Nutrients

A quarter of the growers connected raised the topic of nutrients in reclaimed water. They report: no difference between bore and reclaimed water; slight increase in colour of crop; more nutrients and it is clearer and cleaner; and no algae problems with covered storage tanks. Advisers suggest that algae was more of a problem in the winter months but similar problems exist with bore water.

4.7 Water supply and demand

There is approximately 17 GL/a contracted to growers with around 15 GL/a supplied. If the planned extension of the pipelines goes ahead, the contracted amount will reach 19 GL/a by the end of next year.

Access to contracted water allocations

Growers would like less restriction on daily access but understand the need for the daily limit in order to meet system demand. An increase in supply is wanted by 75% of the growers when it is needed most, particularly in the summer months. The five-year commitment to purchase of the water was a concern for

some and reassuring for others. A review of allocations is requested by many of the growers to see if there is a better way to allocate and supply water on a day-to-day basis.

Storage

All farm types use dams and tanks to store reclaimed water. At least 24 hours storage is required as stipulated by the WRSV contract (WRSV 1997:8). This is to provide balancing storage, however, there is some confusion over the period of storage required and the purpose of holding the water.

Transfer of water

There is uncertainty in relation to the rules governing the transfer of water. Some growers believe the transfer of water is not allowed and one would like an amalgamated system so water can be transferred between properties, yet, others confirm that they are already doing this.

4.8 Costs and pricing

Historical factors

It is claimed by some growers that the BOOT scheme was originally proposed for transferring back to the growers. The fact that it was established to transfer back to the SA government (which the growers understand as being 'SA Water') has implications for growers' concern for future pricing of the reclaimed water.

Contract pricing

Almost three quarters of growers understand the pricing arrangements. A quarter of these are happy with the current price of the water. Concerns were expressed around the penalties charged for over using an allocation and the CPI based increase. By arrangement, some growers are not charged excess water usage fees at present due to spare capacity in the pipeline.

Cost comparisons

Several estimates are made of the cost of reclaimed water in comparison to other sources. Some believe the cost to connect to reclaimed water and bore are about the same.

Take or pay

The majority of growers are concerned about paying for an allocation whether the water is used or not, with a quarter of the growers specifically advocating a 'user pays' system. Some suggest that a review of the payment system should be undertaken.

4.9 Management practices

Few changes were noted that specifically relate to reclaimed water. In some cases the introduction of reclaimed water provided an opportunity for growers to improve their general farm management skills and knowledge through the increase in workshops.

Water management

A third of the growers have changed their irrigation practices since connecting to reclaimed water such as irrigating for longer periods to leach salts from the soil. Management strategies need to be implemented

to counteract the effects of salt on crops; although some bore water also has high salt levels. One grower upgraded his irrigation system due to access to a greater volume of water, and another obtained a longer life out of his irrigation T-tape than with the previous 'channel' water.

Growers assert that over watering would ruin their produce and exacerbate salinity problems. Only one grower admitted that he over watered. Advisers believe growers would benefit from training in irrigation efficiency and understanding their irrigation systems.

Nearly 70% of respondents connected to the VPS have access to at least one other water source. It was confirmed that many shandy the reclaimed water with bore water, and some use rainwater to reduce salinity levels, or mix it with other sources to increase the volume of water needed in peak seasons.

Growers interviewed do not tend to use water-monitoring devices as they either do not trust them or believe it is better to observe the crop. The difficulty in monitoring is acknowledged by horticulture advisers who either suggest some growers do not water enough or that they put too much on.

Glasshouse growers are more likely to undertake water testing than the other producer groups. WRSV conducts tests twice weekly to ensure they are being supplied with the water quality SA Water has undertaken to provide. United Water has a continuous monitoring system to ensure that the water delivered to WRSV meets contractual requirements.

Soil management

A horticulture adviser has observed that there is a modest proportion of growers that are doing soil management properly and there are a lot of growers partway there. Some of the growers, mostly glasshouse, apply gypsum to negate salt in the soil. Horticulture advisers agree this is useful although one warns that other essential nutrients, such as selenium, may be lacking in food grown on the NAP due to the application of gypsum for soil sodicity, salinity and poor drainage. Leaching the salts from the soil is also practised, with some mounding to assist in the process. Others use collected rainwater stored in dams and tanks. One adviser recommends that growers need to apply more water to leach the salts below the root zone.

Some of the growers have soil testing done either through their fertiliser supplier or the VHC. A few growers have undertaken soil management workshops.

Fertiliser management

Two glasshouse growers have changed their fertiliser applications since using reclaimed water; a broadacre grower is using the same amount but is expecting to reduce his applications. One glasshouse grower claims he uses less fertiliser. A hydroponics grower states that if he had to use more reclaimed water in his blended source that, due to the salinity levels, he would use twice the amount of fertiliser. One adviser asserts that the "fertiliser application rate needs to consider the NPK levels in the water" (23:2). While another states it is "no good doing soil nutrition unless they get the irrigation right, because the salt interferes with all the uptake of nutrients" (50:32).

Pesticide and Fungicide Management

Only one glasshouse grower reported on pesticides, commenting that he has to use mains water to apply chemicals as the reclaimed water could not be used on the plants' leaves. One horticulture adviser recommends that reclaimed water not be used for mixing with pesticides or fungicides.

4.10 Environmental impact

General comments relating to the scheme are: its bringing people back into the district; it has made growers drought proof and sustainable; the growers were providing a public benefit but their understanding of the scheme was not great; good idea to get rid of the effluent water; and some concerns relating to unknown effects of reclaimed water on the land. An environmental adviser points out the complexity of the water situation on the NAP and the interrelationships involved.

Aquifer depletion and recharge

There has been an overall reduction in groundwater use as the reclaimed water has been substituted for it, according to one horticulture adviser, but there has also been a clear increase in production and increase in total water demand.

Broadacre growers generally commented in relation to the depletion and recharge of the aquifer. They claim that reclaimed water has taken the pressure off the aquifer and the basin is refilling. A few growers express their frustration with the mixed messages received from Government organisations as to what is happening to the basin.

Horticulture advisers claim that: growers saw the VPS as an opportunity to secure their production; some moved into more marginal areas; were aware of the problems with the aquifer and knew something had to be done; are not recognized for contributing to the recharging of the aquifer; and they do not have the time to fully appreciate the situation.

Water tables

Generally, the growers consider the matter of perched or rising water tables in relation to their own property and only a few take a broader view. Both the advisers and growers express uncertainty or attempt to clarify the situation. Growers believe that the water table: comes from the first quaternary (Q1) aquifer or water travelling from the hills area; it pushes the salt to the surface mostly in winter; rises if bore water pumping is slowed down; and would flood properties.

Some advisers and regulators acknowledge a seasonal shift in the water table and as a result it is difficult to directly relate the rises to reclaimed water. Both advisers and some growers agree that irrigation is linked to the rise in the water table.

Drainage

An adviser and grower attribute poor drainage to be a main contributor to the rising water table. They believe this is due to modifications to the landscape, which block off the natural drainage pathways across the plains.

Monitoring

The monitoring of groundwater and surface water was mentioned by several of the stakeholder groups that agree there has been insufficient monitoring in the region to understand the water balance of the region. A grower claims that he tried to talk to the Government about monitoring the water table but was ignored.

A network of groundwater monitoring wells – ObsWells - has been installed for several years across the region to measure salinity and water levels. The data from the ObsWells can be accessed over the internet. An additional 56 wells have been installed since 2003 and a report is being compiled.

Historically the NAP contains shallow water tables and is at risk when irrigated (Stevens et al 2003:16). The VHC and the Northern Adelaide and Barossa Catchment Water Management Board (NABCWMB) have successfully received funding to establish a shallow water table monitoring network and to pilot a sub-surface drainage scheme, to determine how efficiently water can be extracted from the surface. Several stakeholders recognise that hydrological data is now available but there are no resources to interpret them. An estimate of the contribution of irrigation to the water table is 60% (Stevens et al 2003:9). It is recommended that a Land and Water Management Plan be implemented (Stevens et al 2003:16). However, it is also suggested that growers are involved in water monitoring practices (Thomson 2004:3).

Water and Irrigation Management Plans

An Irrigation Management Plan (IMP) is part of the licensing requirements of the scheme (see South Australian Reclaimed Water Guidelines 1999:33). It is claimed a Water Quality Management Committee meets every year and one of its functions is to approve and accept the IMP monitoring report. An environmental adviser claims that monitoring of the IMP needs to be undertaken by the various organisations such as Primary Industries and Resources South Australia (PIRSA), Department of Water, Land and Biodiversity Conservation (DWLBC), SA Water, the Catchment Board, WRSV, and EPA to confirm the different responsibilities for each organization.

A few of the stakeholders agree that a holistic view is required to gain a complete picture of the effect of irrigation, rather than the narrow focus on reclaimed water; activities of the various stakeholders need to be well coordinated to take management of the issues to the growers (Stevens et al 2003:7); and water monitoring needs to occur to ensure responsible irrigation management. The practical Full Stop wetting front detector developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and a grower based irrigation annual reporting framework has been successfully used in the Angus-Bremer district and Clare Valley to assist in irrigation efficiency and the preservation of groundwater sources and could be implemented in the NAP (Thomson 2004; Thomson & Poppleton 2005).

4.11 Related issues

Market

Several respondents representing different groups raised the issue of a ‘glut of produce’. Various groups claim that this is due to the introduction of reclaimed water, which has allowed more produce to be grown. The potential expansion of the pipeline to Angle Vale raised some concern in relation to attracting more farmers, which would result in increased produce. A suggested solution to the problem is to increase focus on the development of export markets, which will take the produce, however, Government support is needed to ship the produce and establish the overseas markets.

QA and packaging

Almost three quarters of the growers connected have a QA system. These included: FreshCare, Hazard Analysis and Critical Control Point (HACCP), SQF 2000, or WQA. Some growers did not see the need to adopt a QA system. The packaging of produce was either done by the growers themselves or through packing sheds. Some wholesalers claim that, generally, the standard of packaging in Adelaide could be improved and the presentation is affected by growers picking the produce too early.

Hydroponics

To overcome soil diseases, and to increase production levels, some policy makers are promoting hydroponics technology as the way of the future. The higher technology will need to be accompanied

with a "higher level of management and people management skills" (59:21). Growers understand that RO would be needed to convert the reclaimed water to usable water for hydroponics and may prove too costly.

Labour

Most respondents agree that labour is one of the challenges facing the industry and is the most significant cost in production. Some claim it is difficult to find trained labour and people who are willing to work. However, one large packing business chose to establish the enterprise in the region because there is an accessible labour pool in the nearby suburbs. Many glasshouse growers operate as family businesses, relying on their wives, children or other relatives for help during planting or harvesting.

Future of the NAP

Expansion of the Pipeline

Negotiations are underway to expand the VPS to the Angle Vale region north of Virginia. WRSV advise that, potentially, another 3 GL/a will be taken up in extension and this will bring the scheme up to the 19 GL/a capacity. A few of the existing users are concerned that it may affect their existing markets and the pipeline is not big enough to support the volumes required.

Aquifer Storage and Recovery (ASR)

ASR was discussed with the growers in the development of the VPS. Many of them resisted the scheme as they were concerned about further degradation of the groundwater supply (Taylor et al 1995:16). ASR technology has since been further developed through a CSIRO and United Water International Pty Ltd project, receiving international recognition.

General reflections

A few respondents raise the possibility that the NAP will evolve from horticulture production to providing housing. Some growers believe that outside competition will overcome the local market and a few wish to escape the mundane routine involved in mono-crop glasshouse production. Others are optimistic about their future. Advisers, too, believe there is a good future on the NAP but explain that this will depend on sustainable management practices.

5 Discussion

The discussion works through the main findings of the report to illustrate opportunities to build trust in the use of reclaimed water for horticulture irrigation.

6 Conclusion

The use of Class A reclaimed water for irrigation in the Virginia area is generally accepted by growers and the market. One grower claims it has "brought people back into the district" and "made growers drought proof and sustainable". In terms of public health the strategies that were implemented on the introduction of the water appear to have allayed concerns. There is however a level of background noise relating to the potential long term effects of growing food crops with reclaimed water.

There was a strong expression of need for increased access of reclaimed water in the peak growing season, and there are calls for a review into the allocation of the water now that the scheme has had five years' operational experience. The overriding message from growers is that a 'user pays' system would be preferred to 'take or pay' as some growers are paying for water they are not using.

The growers still hold a general concern regarding salinity issues, although these may not necessarily relate to reclaimed water. Salinity is an ongoing problem in the region and is a difficult issue to address, as there are several potential contributing factors. These include the rising water table, existing saline bore water, questionable fertiliser and soil ameliorant use, and efficiencies relating to the volume of water applied.

Stakeholders agree that there needs to be a more holistic view and coordinated approach to monitoring and reporting of data in the region; and strengthening of relationships amongst and between supporting agencies and the growers in order to achieve sustainability.

After five years' experience of reclaimed water irrigation, Virginia growers in various ways state that they value the water; QA advisers and wholesalers discern no difference between crops grown with reclaimed water and other water sources; and the two major retailers contacted confirm their policy of acceptance provided the current level of quality control is maintained.

7. Recommendations

The following recommendations are made for consideration by all the stakeholder groups involved in the implementation of recycled water schemes. Where possible, all stakeholders (particularly growers) should be involved in decision making and implementation of strategies to ensure community ownership of the processes and outcomes.

1. Review the pricing structure particularly relating to 'take or pay'.
2. Make provision for a review of water allocations in 'take or pay' schemes.
3. All stakeholder groups (including growers) should be involved in investigations to lower salinity levels in reclaimed water.
4. Discussions should commence with growers and relevant state agencies to establish an irrigation monitoring network (eg ground water monitoring) and irrigation scheduling technologies (eg CSIRO's Full Stop system).
5. Assess the most effective method for communication with different ethnic groups. This may include the continued employment of a bi-lingual or multi-lingual community liaison officer (full time) to build links within the community.
6. Provide a targeted education programme on reclaimed water and particular features of the scheme, including contractual documents, for people associated with giving advice to growers and developing policies relating to irrigation and environmental management.
7. Ensure that there is ongoing information readily available on reclaimed water in general and the scheme in particular for all stakeholders.
8. Determine the most appropriate methods for training for growers in the areas concerned. The study indicates that more participatory styles of teaching are suitable to ensure practices reflect learning preferences.
9. Provide opportunities for new entrants into horticulture to access training specifically relating to reclaimed water and provide follow up training and information for growers on an ongoing basis after connection to reclaimed water to keep them informed and to clarify any misunderstanding of contract rules.
10. Continue to investigate alternative market opportunities for crops that are irrigated with reclaimed water.

11. Ensure that findings related to consumers' perceptions of reclaimed water are communicated to all stakeholders to ensure continued market stability.
12. To assist with the transfer of information between growers and between various agencies and organisations, consider locating all local services that relate to reclaimed water in the one building.

GLOSSARY

Aquifer	A rock or sedimentary layer that is sufficiently permeable to conduct groundwater to a well or spring (DWR: undated b).
APM	Adelaide Produce Markets
BNR	Biological nutrient reduction wastewater treatment process.
Bolivar water	A term used by some research participants which refers to Class A reclaimed water provided by the VPS.
BOOT	Build Own Operate Transfer
Channel water	One of the terms used by growers to refer to the water extracted from the Bolivar effluent channel, also referred to as 'green water' and Class D reclaimed water.
Class A reclaimed water	Water sourced from sewage effluent treated to tertiary standard as specified in the South Australian Reclaimed Water Guidelines (1999).
DAFF	Dissolved Air Flotation and Filtration: The DAFF Plant that polishes secondary treated effluent at Bolivar WWTP prior to distribution through the VPS.
DWLBC	Department of Water, Land and Biodiversity Conservation
EPA	Environment Protection Authority
GL	Gigalitres; being one thousand ML.
GL/a	Gigalitres per annum.
Green water	A term used by growers to refer to the water extracted from the Bolivar effluent channel, also referred to as 'channel water' or Class D reclaimed water.
Groundwater	That part of sub-surface water that is in the zone of saturation, or all sub-surface water as distinct from surface water." (DWR: undated-b)
HACCP	Hazard Analysis and Critical Control Point
IMP	Irrigation Management Plan agreed for the VPS.
ML	Megalitres; being a million litres.
ML/a	Megalitres per annum.
NABCWMB	Northern Adelaide and Barossa Catchment Water Management Board
NAP	Northern Adelaide Plains – the geographical location that embraces Virginia.
NHT	Natural Heritage Trust
PIRSA	Primary Industries and Resources South Australia
QA	Quality Assurance. The acronym used for quality assurance systems and advisers that ensure food safety and superficial quality criteria such as appearance.
RO	Reverse osmosis
Salinity of water	A measure of the amount of salt in water expressed as milligrams of salt per litre of water (mg/L). In this form it is termed total dissolved solids (TDS). There is an approximate relationship between TDS and electrical conductivity (EC) which is measured as micro-Siemens per centimetre (µS/cm) or deci-Siemens per metre (dS/m). For the VPS water the relationship is: 1000 µS/cm EC = 1 dS/m EC ≈ 640 mg/L TDS.

SARDI	South Australian Research and Development Institute
SA Water	South Australia's water corporation responsible for water and sewerage services
Shandy	To blend two or more water sources to reduce the salinity levels of water
TDS	Total Dissolved Solids (see 'Salinity of water')
VFA	Vietnamese Farmers Association
VHC	Virginia Horticulture Centre
VIA	Virginia Irrigation Association Incorporated
VPS	Virginia Pipeline Scheme: the reclaimed water pipeline from Bolivar Wastewater Treatment plant to Virginia.
Water table	The surface formed by the water in the saturated zone within an unconfined rock or sediment" (DWR: undated b)
WQA	Woolworths Quality Assurance
WRSV	Water Reticulation Systems Virginia – The private operator of the VPS based on the BOOT agreement with SA Water.
WWTP	Waste Water Treatment Plant

1 Introduction

The Virginia Pipeline Scheme (VPS) is the largest scheme of its type in Australia (SA Water 2005; EarthTech 2005) and was established in 1999 to deliver unrestricted Class A reclaimed water to irrigators on the Northern Adelaide Plains (NAP) in South Australia. The region is located within close proximity to Adelaide and provides approximately 30% of the capital's vegetable needs (Boomer 1999:14), and around one quarter of the State's horticultural output (Food for the Future 2001:1). This equates to a gross farm value of $72 million and a food processing value of $203 million (Food for the Future 2001:2). The main horticulture crops grown in the Virginia region are broken up into three main categories. These include: broadacre vegetables (4,123Ha); Glasshouse crops (597Ha), which include all crops grown undercover; and perennial crops (785Ha) (Hogan et al 1999).

The research for this report has been conducted through the Sociology Department at Flinders University (South Australia), for the Department of Primary Industries Victoria, with funding obtained from the Land and Water Australia National Programme for Sustainable Irrigation, and Horticulture Australia Limited. The purpose of the research was to investigate and report on the various stakeholder perceptions of reclaimed water used in the VPS from its development and operation up to the present. The results will feed back into a larger study on the use of reclaimed effluent water in Australian Horticulture (Boland 2004a; Boland 2004b) and the communications project Coordinator for Recycled Water Development Horticulture (CRWDH, 2005). The objectives of the study were to:

(iii) review the key issues associated with a scheme that has been running for 5 years and learn from these in the application to other schemes
(iv) understand the current communication deficiencies with the view to assessing the impact of current activities in the future.

The research was conducted using an embedded case-study design. A semi-structured approach to interview questions was undertaken to allow participants to convey information they considered to be important. A total of 75 participants contributed to the research, some of whom had multiple roles across the stakeholder groups. These included: growers, quality assurance advisers, major retailers, wholesalers, regulators, water providers, water policy/strategy advisers, horticulture and irrigation advisers, industry groups and associations and industry associated businesses. Participants were either interviewed or a statement was obtained in person or over the telephone. A verbatim recording was made of the information gathered from a tape recording or hand written notes and then transcribed for analysis.

An indication of the structure of the report is as listed below:

- Literature research gives a brief review of the literature relating to peoples perceptions of and trust in reclaimed water and the associated literature on risk perceptions and adoption of new technology.
- Design and methodology gives an outline of the research method, ethics considerations, description of the participants, interview protocol, data recording and analysis and reporting.
- Findings draw out the participant's demographics; previous research in relation to the VPS; and the participant's views on topics such as the scheme establishment, communication and information, reasons for accessing the VPS, water quality, water supply and demand, costs and pricing, management practices, environmental impact, and related issues.
- Discussion works through the main findings of the research.
- Conclusion summarises participants' experiences of the VPS.
- Recommendations are made on what the researches see as areas needing further investigation or implementation.

2 Literature review

This review focuses on contributions from the social science literature that firmly relate to the concept of using reclaimed water for the irrigation of food crops. The practice is not new and it was recently reported that one-tenth of the world's crops are grown with sewage effluent and that this involves almost 50 million acres of farmland around the world (Pearce 2004). Israel, the USA and many countries from the 'Third World' have used sewage effluent for agriculture for decades and in 1985 an international group of experts concluded that the then current guidelines were too conservative, and it was feared the costs involved in meeting stringent conditions would encourage unregulated use of the resource (Shuval 2003).

While the irrigation of horticulture crops under the VPS is guided by the high water quality standards set for this purpose in the South Australian Reclaimed Water Guidelines (1999), the practice is relatively new to Australia, particularly for the irrigation of salad crops that are to be eaten raw. The topic is also new to the social sciences and it has been established that there is little published literature on the matter (for example Marks 2003; Po & Nancarrow 2004). Therefore, it is argued that adoption of the new technology, that converts human waste to a water source fit for irrigating food crops, will be influenced by a range of factors. In addition to the characteristics of the social actors involved, the acceptance of the level of uncertainty involved will primarily depend upon the degree to which the "institutions which are responsible for the assessment and management" of the initiative are to be trusted (Short 1984:714; Douglas & Wildavsky 1982:89; Collins & Pinch 1993:148).

The issue of sustainability also arises and, in the Australian context, this reflects the findings of the Bruntland Report (1987) that focuses on the broad intergenerational justice issue of meeting "the needs of the present without compromising the ability of future generations to meet their own needs". This underlying principle has been mainstreamed to the now familiar mantra of 'the triple bottom line' for responsible economic development. And, with growing concern for the environment, commentators now embrace the unambiguous theory of the 'ecological footprint' (Rees 1997, for example Harding 2005) arguing that a more global view is required to protect the environment from unsustainable Western urbanised production and consumption.

Therefore, social uncertainty of future outcomes not only relates to the immediate but also yet unseen effects. Some social scientists advocate the importance of both 'top-down' (government, legislation) and 'bottom-up' (end-user, consumer) processes for the development of trust (Misztal 2001; Sztompka 1999). Top-down support is derived from regulations that are made known to end-users, institutional follow-up to ensure compliance of regulations, familiarity gained through ready access to information and education, transparency of organisational structure and processes and accountability (Sztompka 1999; Giddens 1994). Bottom-up processes arise through the characteristics of the social actors involved, for example their attitudes and behaviour. The interaction between the two levels – the structural support and characteristics of social actors – will produce either a more trusting, or less trusting disposition, depending upon the quality of that experience (Sztompka 1999). Trust needs to be actively negotiated and can be withdrawn at any time (Giddens 1994).

In the case of agricultural reuse, ongoing trust will depend upon (1) the historical experience of this practice: how it has affected the communities involved as well as the receiving environment. Support will be shaped further by (2) the structural context: the public institutions such as the Environment Protection Authority and Department of Health regulations, science reports and communications from managers and operators. The interaction with the social actors involved will also be influenced by (3) their personal characteristics: their social mood, skills and education. And the result of the interaction between structure and agency will impact on the social, economic, as well as (5) the natural environment in a way that produces (4) a more trusting or less trusting disposition towards the irrigation of food crops using reclaimed water. Importantly, the process is in continual motion, including the push from the past (the

inherited culture of trust) and the pull of the future (the prevailing culture of trust), with the environment always being an influencing factor, either enabling or constraining action (Sztompka 1990:252-253).

Psychometric, social and cultural studies confirm that risks defined by invisibility are less acceptable than those that can be seen (for example, Fischhoff et al 1978; Fischhoff, Slovic & Lichtenstein 1982; Otway & von Winterfeldt 1982; Sandman 1986). Therefore, whether a risk is voluntarily negotiated or involuntarily imposed or encountered is crucial to societal acceptability (Starr 1969; Fischhoff et al 1978, 1982; Douglas & Wildavsky1982; Marris & Langford 1996). Normative influences such as the opinion of family and peers are important in determining acceptable levels of water quality risk (Canter et al 1992), along with the idea of territory, the obtrusive nature of environmental problems and levels of trust in sources of news (Gooch 1996). The 'innoculation effect' is posited where positive attitudes and awareness of minor incidents act as an immunisation against negative events, whereas those with only a peripheral interest will use an incident to determine their stance on the issue (Renn 1990:156).

Adoption of new technology relies on other factors which may or may not be related to concerns for health or the environment. Innovations to prevent future hazard in farming often require more time and effort for implementation than maintaining current practices; they rely on limited advantages to the adopter conditioned by high initial costs, low economic profitability, increases in discomfort and low immediacy of rewards (Nowak & Korsching 1979). Besides economic considerations, water quality, pre-adoption attitudes towards the innovation and opportunity for control are factors that explain initial adoption (Casey 1997:4055). Access to information and availability of the technology are of obvious importance (Wilkie 1986; Audirac & Beaulieu 1986). A resource back up will be required, including labour, family or other socio-economic support (for example, Filho, Young & Burton 1999).

For public consultation, ways of addressing multiple claims and values is theorised via 'communicative' processes rather than the alienating effect of 'strategic action' (Habermas 1990). This underlying principle has been used to guide public communication and participation for deliberating a forestry proposal (Webler and Tuler 2000) and a similar approach was undertaken in the development of at least one urban water strategy (Syme & Nancarrow 2002). The key elements of social justice and the principles of effective communication involve multiple sources and methods (for example, Hamlyn-Harris and Cole-Edelstein 2000) and have been outlined for public participation in the consideration of water recycling to work alongside project planning, design, implementation and management (Marks 2004). The need to establish a more permanent structure to feed information and data between local end-users of water on the periphery and scientific experts at the centre is put forward to democratise the traditional top-down knowledge transmission process (Abbott 2001:32). A reconfiguration of power relations in deliberating effective and sustainable water reuse is suggested in recent reports on the experience of potable reuse (Hartling 2001; Marks 2003; Stennekes, Colebatch & Waite 2003) which may be realised by developing the elements of effective knowledge transfer as outlined by Abbott (2001:32).

3 Design and methodology

3.1 Research aims and objectives

The overall brief for this research, received in August 2004, was to investigate and report on stakeholder perceptions of reclaimed water in relation to the VPS. The objectives of the research were to undertake data collection prior to the end of December 2004, to analyse the data and to furnish a report through the Department of Primary Industries, Victoria, by the end of February 2005. Design, management, and ethics submission and approval were undertaken prior to the commencement of data collection in October 2004. Direction on the type of stakeholders to include was obtained through discussion with the Project Management Committee. It was agreed that stakeholders would include Quality Assurance (QA) advisers, major retailers, wholesalers, policymakers and growers. It was also suggested that consumers be included, however there were insufficient resources to adequately cover public perceptions within the timeframe. However, the researchers later saw the need to include horticulture advisers who have regular contact with growers. It was agreed that a brief summary report of the findings should be fed back to the reclaimed water providers, the Virginia Irrigation Association Inc. (VIA) and the Virginia Horticulture Centre (VHC).

3.2 Methodology

The 'case study' method is a generic term, which does not specify the levels of secondary and primary data collection involved. That is, whether analysis of a study is derived from documentation only, or interviews with managers, or verified with actual users of a program. The embedded design specifies the project level, intermediate and individual levels of data collection that include interviews with the actuals users of the programme, in this case, growers, as well as documentation collected in the field. The summary of the type of qualitative data collection involved is detailed in Table 1.

Table 1 Embedded case study design

Unit of analysis	Data sources	Project level data	End-user
Main unit			
Project	policy and information documents, websites, observations	historical context and current strategies	background; familiarity, compliance with policies, recommended practices
Sub units			
Intermediate	archival data: media reports, previous research, industry literature	aspects of project such as charges, research, communications.	awareness of media and research reports, event coping procedures
Individual			
Managers	interviews with QA auditors, policy makers, water suppliers, wholesalers, retailers, advisers	attitude towards policy, economic, technical issues, communication	quality of communications, service
Growers	interviews / focus groups, observations	practical experience of reclaimed water service	knowledge, beliefs, attitudes, behaviour

3.3 Ethics considerations

The Flinders University of South Australia Social and Behavioural Research Ethics Committee approved the research proposal in October 2004. Each research participant was supplied with information relating to the research project (for example, Appendix 1a, an information sheet for growers), and they were asked to sign a consent form (for example, Appendix 2a) to allow the interview to be taped, or recorded for data analysis and reporting. Consent forms and information sheets were reproduced in the Vietnamese language to issue to participants with a Vietnamese background who had difficulty with English (for example, Appendix 1b and 2b). Interpreters assisted in the interviews of Vietnamese and Cambodian research participants.

3.4 Research participants

Experts and key informants were identified within policymaking and support agencies and contacted by telephone for interview. Most of the growers were approached through an introduction by horticulture advisers who had regular contact with them; for example, SARDI and Rural Solutions SA staff, including interpreters working through the VHC. Growers were not contacted unless they had been referred to the researchers; for example, no one was approached through a list or telephone directory. The number of people involved in any of the stakeholder groups depended on the complexity of the issues raised and the need to confirm the frequency or importance of these issues.

Originally it was thought that twenty growers would be interviewed and that one or two focus groups would be conducted with Vietnamese and Cambodian participants. However, focus groups proved to be impractical to organise during the busy Christmas season. A diverse range of participants was targeted for interview, which included one or two influential growers (known for their community leadership or involvement) and broadacre, perennial and glasshouse growers, as well as several growers not connected to the scheme. Not all who were contacted could elaborate on their experience of the VPS and chose instead, to briefly outline their views over the telephone. Vietnamese and Cambodian interpreters assisted during interviews when required, being either a professional interpreter or a family member or friend. A summary of the numbers and types of participants recruited for the research is outlined in the results Section 4.1 in Table 3.

3.4.1 Response rate

The response to requests for interview were remarkable, particularly considering the unavoidable timing of the main data collection from 5th November to 23rd December 2004, during the Christmas rush. Only two growers and two wholesalers declined to participate. Some difficulty was experienced in obtaining documentation on previous projects undertaken in the region and printed material relating to reclaimed water, the majority of which was not available until late December 2004 and early January 2005. A total of 30 in-depth interviews and seven statements were conducted with growers. Some difficulty was experienced in obtaining documentation on previous projects in the region.

3.4.2 Interview protocols

An exhaustive list of questions was initially devised to guide interviews with growers and was refined through feedback from the National Steering Committee under The National Program for Sustainable Irrigation. These are summarised in Table 2. Questions for the other stakeholder groups were structured around their involvement or role in the scheme and their perceptions or experience relating to its implementation up to the present, and their understanding of growers' perceptions of the VPS.

A semi-structured approach to interview questions was undertaken to allow all the participants to convey information they considered to be important. In the case of growers, if time and interest permitted,

information was obtained to complete the basic profile of each grower. However, this was not always possible due to (a) time constraints; (b) because the participant felt this information was not relevant to their experience of reclaimed water; (c) privacy and confidentiality concerns; and (d) that this information had already been provided or was similar to a number of casual enquiries made in the past.

Table 2 Protocol for semi-structured interviews with growers

Question	Theme explored
Background	History, prior experience, cultural background, arrival on NAP
Type of crops grown	Including farming practice: glasshouse, perennial, broadacre
Sources of water for irrigation	Availability: selection of sources
First aware of reclaimed water	Initial response/reactions to reclaimed water
First to connect	Initial response/reactions to reclaimed water
First impressions	Initial response/reactions to reclaimed water
Costs: monitoring, set-up, storage	Economic benefit/burden/neutrality
Personally experienced factors:	
e.g. quality	Experience: water quality
changed practices	Accommodating reclaimed water
allocation days / volume of water	Water demand
price	Price satisfaction
contractual documentation	Familiarity with contract obligations
information	Information sources: basic and expanded interest
Benefits of reclaimed water: environment, fertiliser use, cost	Economic/environmental/social benefits
Others' experience with reclaimed water	Response/reactions to reclaimed water
Understand water issues	Environmental awareness
Farming Practices: soil and water management	Sustainable management
Testing: soil, plant, water	Sustainable management
Where to for advice	Trust in information sources
Water quality: who is responsible	Accountability
Types of information most useful	Trust in information sources/ access to and availability of information
How service can be improved	Constructive criticism
QA programs	Modernisation: QA obligations
Training	Education
Future for reclaimed water	Sustainability, acceptance
Future for Virginia horticulture area	Future predictions

3.5 Data recording and analysis

In most cases, interviews were audio taped with the permission of participants. However, in some cases, notes were taken in either longhand or shorthand if recording was considered unacceptable, as in one case only, or inappropriate (several instances). Either way, verbatim recording was made of information gathered and then transcribed. Each set of data was given a case number and respondents were assigned a fictitious name to conceal their identity. Further, in the typed transcription, each statement was numbered, including the researcher's input, for ease of tracking the source of the data used in writing up the findings. Descriptive summaries were generated for sub-groups; for example, the proportion of participants who formerly used the Class D sewage effluent before the VPS was established. Summary responses were also tabled to indicate the main claims, concerns and issues of each person interviewed, and further subgroups were consequently identified. From the text, quotations were selected that either represent a particular theme raised by others or a different perspective.

3.6 Reporting

This report provides a presentation of the main findings. All transcripts were analysed to identify similarities and differences between individuals and group experience. Quotations are identified by a short description of the type of respondent – whether a grower, adviser or other informant - along with the transcript number and the relevant statement number. Descriptive information for some respondents is minimal and a list of participants with their transcript numbers is not given in order to conceal identities. Although fictitious names were given to each respondent for data processing and analysis it was decided that that these would not be used for the report because of the number of participants involved. The findings reported are those that were obtained from interviews with participants and are based on their understandings and perceptions. Some statements may not be factually correct.

4 Findings

The demographic details of research participants are followed by the audited findings of previous social research conducted in relation to the VPS and conclude with the results from this current research. The semi-structured interviews in the current research gave respondents the opportunity to volunteer information, in their own terms, of their particular experience of the VPS. A range of claims, concerns and issues surface in relation to the reclaimed water service. These are presented under theme headings followed by a summary of related issues, such as various other facts that contribute to sustainability in the region. Generally, findings from growers are presented first, followed by accounts and opinions expressed by other stakeholders, as well as verification from relevant documented evidence.

4.1 Demographics

The number of research participants that contributed to the research total 75. However, 13 participants out of the 75 have multiple roles across the stakeholder groups. The total number of representatives for each group is shown in Table 3. It is noted that the horticulture industry on the NAP is male dominated, at least in relation to public office or communications, as only two females were amongst those interviewed.

Table 3 Research participants (n=75)

Stakeholder group	No. represented	Growers and agencies represented
Growers	36	Seven have multiple roles, eg wholesalers, industry associations, horticultural consultants
Quality Assurance advisers	2	These work with most of the wholesalers interviewed
Major retailers	2	The major multi-nationals
Wholesalers	9	Three made statements and seven were interviewed at Adelaide Food Markets Ltd, Pooraka
Regulators	3	Department of Health; and two informants from the EPA
Water providers	3	SA Water, United Water, WRSV
Water policy/strategy agencies	3	Included PIRSA and NABCWMB
Horticulture and irrigation advisers and researchers	12	DWLBC, SARDI, Rural Solutions SA, private consultants
VHC Board	6	Members of the Executive Board
Industry associations	6	Current and previous members of the VIA executive and one member of the VFA
Industry associated businesses	6	Various horticultural supplies and professional services.

4.1.1 Growers

In total, 36 growers contributed information in this research. Thirty of these were interviewed in depth on their property and six provided statements. The participants include 13 broadacre, 12 glasshouse, 6 perennial, and 5 perennial-glasshouse growers. Hydroponics is practised in part or entirely by three and the term 'glasshouse' refers to under cover crops: poly-house, shade-house and glasshouse.

There are various assessments on the demographics of growers in the Virginia region. It is reported that migrants from Greece and Italy came to the area in the 1950's. The Vietnamese and Cambodian migrants settled in the area in the 1980s and now account for 90% of glasshouse production (Hollow 1999:12). It is estimated that the region supported 1,000 growers in 1999 (Boomer 1999:14) comprising 600 glasshouse and 400 broadacre growers (Hollow 1999:26), employing around 3,000 people (Boomer 1999:14). Cultural backgrounds associated with glasshouse production suggest 400 Vietnamese, 50 Cambodian and 50 Greek growers are involved (Hollow 1999:26). Another published estimate in 2000, reports 1400 growers with an estimated annual turnover of $160 million (Kelly and Hollow 2000:3). At the micro level, a local businessman who deals with most Vietnamese estimates that there are roughly 700 families settled in the Virginia area and that in some cases, two or three family members are farming with a total of 1,500 growers involved. One interpreter suggests that there would be 1,200 Vietnamese growers, 100 Cambodian and 70 Laotian growers, while another suggests that around 2,000 to 3,000 Cambodians live in the general vicinity (20:39).

The WRSV manager confirms that there are currently around 285 connections to the VPS involving 230 customers because a number of growers have two or three connections (2:188). He believes that approximately 50% would be smaller concerns on a 10 acre block taking under 25 ML/a; the average broadacre grower contracts for around 100 ML/a (2:186). No details of the cultural mix or farm type of connections could be provided by WRSV. However, three other respondents' estimates suggest that approximately 100 growers from a Vietnamese background and ten with a Cambodian background are connected, with other growers leasing land from the property owners holding these contracts. The cultural background of commercial growers registered with the VIA is as shown in Figure 1.

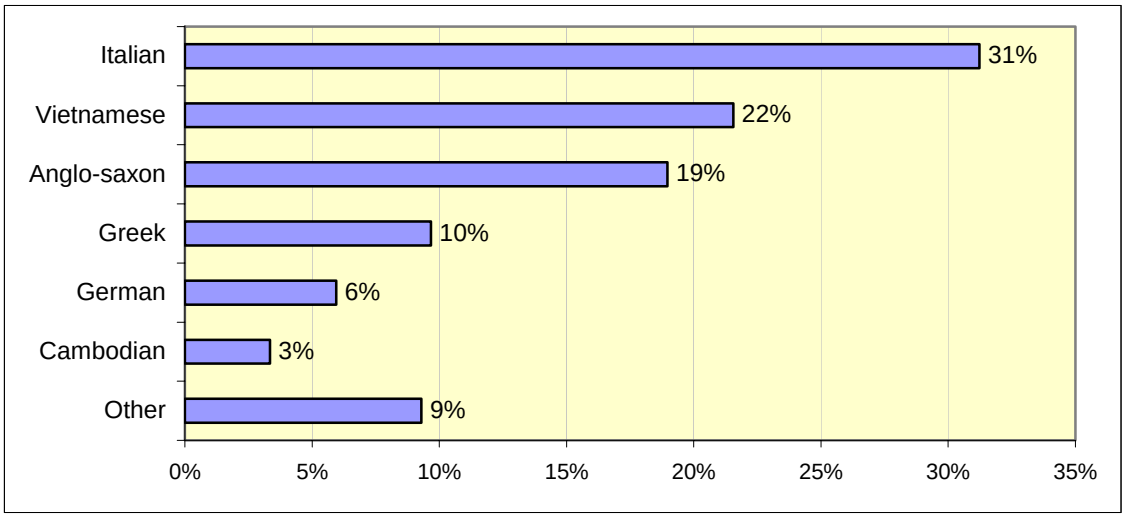

Figure 1 Percentage of growers for each cultural background of members of the VIA (n=269 As advised in December 2004)

All major cultural groups were included in the sample of growers interviewed. The break-down of Anglo Saxon, Mediterranean (Italian and Greek) background, Vietnamese and Cambodian research participants is shown in Figure 2.

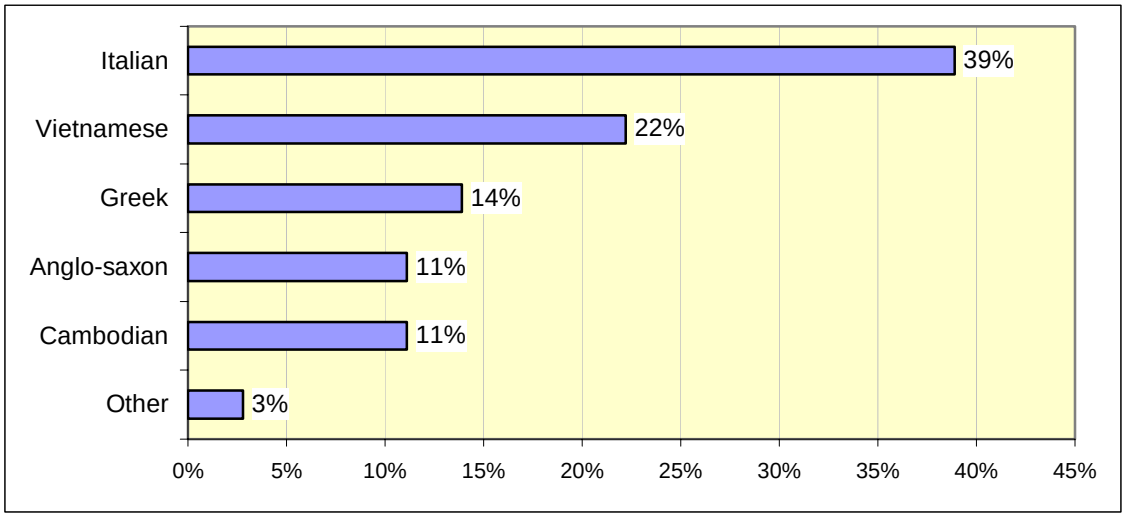

Figure 2 Percentage of growers for each cultural background of the research sample of growers (n=36)

Personal details such as age and education were not asked of growers but were volunteered by participants or observed. The age of the growers interviewed in depth ranges between 30 to 60 years, with the majority being in their 40s and 60s. Educational status of growers from Australian, European and Asian backgrounds all varied from minimal formal education through to tertiary diplomas and degrees. Most of the glasshouse farm types are small family operations while some of the broadacre and perennial farms were larger family corporate entities. However, it is known that some glasshouse growers operate through cooperative arrangements, pooling resources and expertise such as accounting, packing, transport and marketing (49:8) and this was the case for some of the respondents interviewed.

The types of crops currently grown by 35 of the 36 growers interviewed are as shown in Table 4 below. The number of growers represented for each crop category excludes one who is no longer farming. A total of 24 growers interviewed are using Class A reclaimed water, and 12 are not connected to the VPS.

Table 4 Crops grown by respondents (n=35)

Farm practice	Crops	Connected to VPS	Not connected to VPS	No. growers by crop
Broadacre	Broccoli	1	2	3
	Cabbage	1	0	1
	Carrots	9	1	10
	Lettuce	1	0	1
	Onions	1	1	2
	Parsnips	0	1	1
	Potatoes	8	1	9
Glasshouse	Beans	1	0	1
	Capsicum	5	2	7
	Cucumber	2	4	6
	Lettuce	0	1	1
	Tomatoes	5	5	10
	Zucchini	2	0	2
Perennial	Nuts (almonds, walnuts)	2	2	4
	Olives	3	2	5
	Wine grapes	2	1	3

4.1.2 Wholesalers

Nine wholesalers were contacted and seven were interviewed on site at Adelaide Produce Market (APM), Pooraka. The size of the businesses owned by respondents ranged from small operations to large concerns that carry every possible line. Specific mention was made of broccoli, capsicums, carrots, cauliflower, cherry tomatoes, cucumbers, eggplants, grapes, lettuce, melons, onions, pears, potatoes, pumpkin, snow peas, tomatoes, and zucchini.

4.2 Previous social research in relation to the VPS

A study was undertaken by Rural Solutions SA, funded by Natural Heritage Trust (NHT) and Primary Industries and Resources South Australia (PIRSA), to identify the technical, scientific and social barriers to the adoption of reclaimed water on the NAP relating to the production of horticultural crops (Kelly and Hollow 2000). However, the findings are not reported in detail (Kelly et al 2001). Frequencies are not recorded but it is understood that one focus group was conducted in 1998 or 1999 with Vietnamese and Cambodian glasshouse growers and another was held with broadacre growers, all but one grower being from 'English speaking descent' (it is assumed that second generation Australians from European backgrounds were also represented along with Anglo Saxons).

There is no data reported on the findings of the focus group research, however, a questionnaire was given to growers who attended, and it is assumed that all who were present were interested in connecting to the VPS. Verbally, one key informant recalls that around 20 people attended each focus group. Therefore, the total number who completed the questionnaire is estimated to be 40. The data presented is descriptive (percentages; no frequencies available). There are several findings of interest as background to this project and these are summarised in Table 5.

A recent national study was undertaken through the Department of Primary Industries (DPI) Victoria that included interviews with three broadacre growers connected to the VPS (Bewsell & Kaine 2004). It was reported that growers found no need to change their management substantially because the water was as good or better than other sources (2004:1). One grower had upgraded from reclaimed water accessed from the 'old scheme' (2004:10). Another needed to supplement bore supplies but was having problems with salinity because he claimed the wastewater treatment plant (WWTP) did not maintain high enough water levels. The third grower reported that he had reduced his bore water use by 40% (2004:11). The report also conveyed that there were concerns relating to public perception, and the potential expansion of the industry making their businesses, particularly for the smaller growers, unviable due to a reduction in produce prices (Bewsell and Kaine 2004:14).

Hamilton et al (2005:204) in their recent paper on the "position of the Australian horticultural industry with respect to reclaimed water" discuss several topics relating to reclaimed water including: policy and economics, market requirements, guidelines, environmental and agronomic issues, and public health. They conclude that a number of issues need to be resolved with respect to the use of reclaimed water for horticulture, in particular:

- Market analysis for potential expansion of horticulture production
- Commitment to industry to provide continuity of quality and supply to its markets
- Implications of substitution of alternative water sources and security of supply
- Risk assessment modelling, particularly for disease
- Consumer perception analysis
- Pricing for reclaimed water.

Table 5 Prior research late 1998, early 1999: Growers interested in connecting to VPS (n=40 estimated)

Data collected	Glasshouse n=20 (approx)	Broadacre n=20 (approx)
Farm experience	av. 6 years	av. 28 years
Irrigation water source		
Bore water	15%	50%
Effluent	31%	
Mains water	46%	
Shandied water	8% mains and effluent	50% bore and effluent
Water storage		
Dam	22%	100%
Tank	78%	
Problems	small shrimp, Green algae, small snails, leaking dams	salt, Green algae, small snails, leaking dams
Soil		
Health	62% Yes 32% No	60% Yes 20% No 20% 'it varies'
Tests conducted	50% Yes	100% Yes
Tests when connected to reclaimed water	88% Yes	70% Yes
Problem with salinity	36% No 28% Yes 36% Not sure	60% No 30% Yes 10% Not sure
Class A reclaimed water		
Will it be safe	22% Yes 78% Don't know	90% Yes 10% Unsure
Perceived negative effects		
Soil	salinity, sodicity, management, biology, heavy metals	salinity, sodicity, management, biology, heavy metals
Water	water tables, underground aquifer	salinity, underground aquifer and water tables
Produce	quality and market	market quality and bacteria
Perceived benefits	less fertiliser needed, increase in production, ability to grow other crops, reduced costs	less fertiliser needed, increase in production, ability to grow other crops

Adapted from data reported in the Grower Manual (Kelly et al 2001), pp 103-105.

A report conducted for the Northern Adelaide and Barossa Catchment Water Management Board (NABCWMB) on the acceptance of reclaimed water compared the presence of algae in bore and reclaimed water, and investigated the microbial contamination of vegetables irrigated with these water sources (Kelly and Stevens 2001). The researchers found that growers were concerned about the repercussions of selling produce due to the algae growth in their reclaimed water on-farm storage facilities, which may lead to microbial contamination and ultimately the reduced quality of their produce and consumer/wholesaler rejection. They note that:

> Some growers using reclaimed water did not want to be publicly associated with it because of concerns of possible market place repercussions. This grower perception was still prevalent despite the community, grower and wholesaler (buyer) education undertaken prior to the commissioning of the VPS.
>
> (Kelly and Stevens 2001:3)

4.3 Scheme establishment

The VPS came into being due to "a happy coincidence" (5:6) of a range of factors. The underlying issues were the environmental concern coupled with depleting groundwater resources. It is estimated that the Virginia region pumped 16 to 18GL/a of groundwater (tertiary aquifers, T1 and T2) per year (DWLBC: undated b). The demand on the aquifers had formed a "cone of depression" and the end of the summer pumping season saw the water levels dropping to 75m at the centre below the ground (NABCWMB 2001b:8). Although bore water allocations total some 26,500ML/a, with the average use being 18,000 ML/a (NABCWMB 2001 b:7,11), a recommended sustainable extraction is around 8,000 ML/a (NABCWMB 2001 c:11). Further details relating to the issues surrounding the aquifers and groundwater use can be found in the NABCWMB Water Management Plan 2001-2006 (2001).

In conjunction with the concerns surrounding the depletion of the aquifers, the newly formed EPA ruled that SA Water needed to reduce nitrogen discharged to Gulf St Vincent from the Bolivar WWTP, under the Environmental Protection Act 1993 (5:3; Marks et al 1998; Taylor et al 1995:i). The 40 GL/a of sewage effluent had been linked to the decimation of seagrasses (4:34) and periodic toxic algal blooms (Taylor et al 1995:16) which in turn was impacting on the fishing industry.

The growers in the Virginia area were also looking for alternative sources of water and first approached the South Australian Government in the early 1970s to gain access to Class D effluent water, also known as 'channel' or 'green water' from Bolivar, which was shandied with their bore water (30:43-50). Permits were issued to a select group of growers to use the water to irrigate vegetables and dairy pasture but there were restrictions on its use and the irrigators were interested in accessing a higher quality effluent (27:4). The growers maintained that they would be helping the Government by taking the water out of the Gulf (30:31; 55:11; 44:356) and assist in preserving the underground water, to which they wanted continued access in case problems arose with the reclaimed water (30:31; 44:35). One grower summed up the venture through this explanation:

> The simple facts are, reclaimed water was born out of a need. First of all, the underground basin was deteriorating. Secondly, the Class D reclaimed water was causing some problems … In simple terms, we use the reclaimed water to sustain the underground aquifer and also, to clean up the Gulf … it was brought about by a team effort of the government and growers. (30A:31)

Depletion of the groundwater was also causing increases in salinity reportedly trending at around 5 mg/L (≈ 8 µS/cm EC) per annum ([EMS 1994:7] Taylor et al 1995:12). Salinity contours ranged from 800 to 2000 mg/L TDS (≈ 1250 to 3130 µS/cm EC) for both the T1 and T2 aquifers ([EMS 1994] Taylor et al 1995:13, 14). Salinity levels of Class D 'channel' water are the same as Class A reclaimed water (32:83).

To determine if the pipeline would provide opportunities for increased horticultural production and markets, the horticulture group within PIRSA developed a NAP Effluent Pipeline Task Group (Taylor et al 1995:25). The NAP had between 3,400 and 4,000 ha of horticulture which produced approximately $43 million and $59 million worth of horticultural products annually; comprising some 20% of SA vegetable production (Taylor et al 1995:2). It was argued that the introduction of the VPS had the potential to expand the area under irrigation on the NAP to 9,200 ha and thereby increase the value of production from between 100 and 200% (Taylor et al 1995:I).

The Virginia Irrigation Association (VIA) was established by the growers to represent the growers' interests and help establish the pipeline scheme (44:2; 41:108) and after four years of negotiations (44:384), it was agreed that the scheme should proceed. It is asserted that the scheme was specifically targeted to alleviate pressure on the groundwater and all those originally involved had bore water (44:35).

According to a member of the VIA, the VIA won a Federal grant (44:8) of $10.8 million (Euratech 2004; Marks et al 1998) through the Better Cities program and Multi Function Polis (MFP). The balance of funding came from SA Water ($6.7 million SA Water 2005; $6.4 million 44:301) and Water Reticulation Systems (WRSV) to construct over 100 km of pipeline at a total cost of $22 million (SA Water 2005). The $30 million Dissolved Air Flotation and Filtration (DAFF) plant was built by SA Water to achieve Class A quality to the satisfaction of the Department of Health (SA Water 2005). It is reported by two growers that the original plan was to Build Own Operate and Transfer (BOOT) "but it was to be transferred to the growers" after "15 years" (13:29; 44:309). WRSV built the pipeline scheme and are the operators for a 20 year period.

It took six years of negotiations between the awarding of the Better Cities grant to the growers and the end of 1999 when water starting flowing through the pipes (5:29). The industry was asked how much water was required and this caused conflict as they had tiers of use depending upon crop type (27:15). The first proposal was rejected by the growers due to the conditions, which some thought to be "outlandish" (56:1). For example, the price of the water (41:255), and it was proposed that the water be allocated over 250 days necessitating the construction of huge storage to meet summer demands (51:6). A second proposal was drawn up (14:4,6) that produced mixed reactions but the majority agreed upon the 0.54% daily access to their individual allocations to be drawn over 185 days (14:6; 51:164). The VPS, with a capacity to supply 120 ML/d to Virginia irrigators, was launched in November 1999 with the initial goal of delivering 30 GL/a (5:20; Marks et al 1998).

4.4 Communication and information

There are three main vehicles of communication and information in the region. One is the Virginia Horticulture Centre (VHC), which was formed before the VPS, whose main functions are to: support horticulture in the region and to provide growers with information, education and training; act as a collaborator for the horticulture industry to meet market needs; identify and establish new markets; link with other regions and facilitate community development and support; and represent the region on an industry issues at regional, national and international levels (VHC 2005). Another conduit of information is the VIA which originally brought growers together to deliberate issues around groundwater allocations and the development and implementation of the VPS. Every grower connected to the VPS automatically becomes a member of the VIA and correspondingly the VHC. The third is the office of WRSV located close to the VHC.

4.4.1 Early communications

News of the VPS was broadcast through formal and informal channels. Growers advise that they became aware of the scheme from hearing others talking about it (25:20), attending meetings relating to the then Class D water and other meetings, the media (43:196), and through the VIA (26:30). When the scheme began, one grower confirmed that the established safety of using reclaimed water was discussed at the Pooraka Market (13:43). This refers to the VHC coordinated risk management communication strategy to address ideas of "bad water", described by one policy maker involved at that time:

> What we did was we put together a couple of fact sheets. We got a professional PR company to come in and work with us and produce a couple of fact sheets and we also ran a series of workshops for growers and also for people in the market place and we had a workshop down at the central market. (60:82)

Another grower reports that study tours of the treatment process at the DAFF plant are still undertaken (30A:111). As outlined later under public health, (4.5.1), the Department of Health were actively involved in communicating the safety of produce grown with reclaimed water to retailers and wholesalers and a crisis management team met as a matter of urgency to address rumours or negative feedback. SA Water also advise that they were involved in this early stage of community consultation (5:30).

Growers generally thought that the meetings relating to the scheme were informative (43:196; 56:38) in explaining what they were planning to do and how they were going to go about it (51:164) and discussing issues such as salinity, bacterial problems and fertiliser issues (45:18). One grower recalls that in the beginning he thought they *had* to use it (43:200). Another remarks that they "probably did a good job in letting people know about the scheme but what they delivered on was a bit less than what they had promised" (42:215). One broadacre grower, who is also a wholesaler, attended meetings before the pipes were laid and "they showed us the water, and the bloke told us it was drinkable, but he didn't drink it"; he adds that there was no follow-up information given (8:24).

An adviser reports that the government was marketing the benefits of the scheme to the groundwater system and to the marine environment quite strongly and growers accepted what they were told. Rather than really understanding the environmental benefit, they clearly saw the public benefit of taking the water off the government's hands (24:8).

4.4.2 Information on reclaimed water

Various published sources of information have been circulated on the VPS and reclaimed water in general since the scheme was implemented, for example:

- Leaflets and brochures
- A photocopy of overheads (possibly compiled by SA Water or United Water) available through WRSV and one QA adviser outlining the water quality and responsible use (see Appendix 3)
- *ReWater* quarterly newsletter circulated to email subscribers
- The "Grower Manual" (Sustainable use of reclaimed water on the Northern Adelaide Plains: Grower Manual, Kelly et al 2001) (Appendix 4a)

Respondents – growers, wholesalers, and one QA adviser - were asked what sorts of literature they have received on the scheme and were shown examples of the abovementioned information. Although the publication detailed above and commonly referred to as the "Grower Manual" was not obtained until later and a copy was shown to only three quarters of the respondents, it was the publication most recognised. Two growers who were not sure if they had seen it were of a Vietnamese and Cambodian cultural background. However, the wholesalers and one QA adviser had not seen the manual and were interested in the detail. The *ReWater* newsletter had not been seen by any of the respondents except for two growers who were not certain. Only one grower had seen the information supplied by SA Water. This was used by one QA adviser interviewed, but had not been seen by the other. None of the wholesalers recognised this basic information. Only three growers had seen information on reclaimed water in brochures or leaflets.

It is confirmed by two advisers that there were a range of reports completed and the field days and workshops were translated in Vietnamese (27:45). This work targeted issues relating to salt and nutrients that would be present in the reclaimed water, for example:

> A field day would be done on a certain location [soil type] and we would invite growers in that area that had the same soil type and then re-run the workshop in another area. A range of these activities was done including fertiliser application, leaching fractions, soils, nutrition and water management. (27:43-47)

There were a series of workshops conducted when the Grower Manual was launched late 2001 – early 2002 (58b:8-10). Six four hour, half day sessions were involved, two of which were conducted in growers' sheds and another four held at the VHC. Only two growers commented on these workshops to report that they did not attend all of them. A glasshouse grower "found them a bit confusing" (29:58) perhaps because he did not attend all of the consecutive sessions.

4.4.3 Sources of ongoing information

Access to ongoing information on reclaimed water was queried. A few growers advise that information goes through the VIA. One thinks that leaflets are important although "whether growers will read them is another matter, but I think especially if you are starting a new area of it, they are going to want to know as much as possible." (45:271). A glasshouse grower receives information in his post box on workshops and studies people have done but "I don't really look at it" (42:151). A broadacre grower explains that he gets "a lot of information across his desk … it is difficult to keep up – a lot of us are like this." (35:50). A few growers have found meetings the most useful way of gaining information. It was also confirmed by other advisers and managers that material placed in VIA or VHC members' post boxes does not get read. A lot of the material has been found in the post office rubbish bin and, although newsletters have been circulated for years, a member at one meeting put forward the suggestion that a newsletter be distributed to keep growers informed. Few growers have emails or access it, often relying on their children to keep up with that side of technology.

It is clear that wholesalers are not in receipt of explanatory or updated information on reclaimed water but it is understood that QA advisers would access additional information if a problem arose. As far as

retailers are concerned, they rely on their QA people – managers, advisers and auditors – to keep abreast of all issues relating to quality.

Seven growers advise that they have undertaken some form of training through the VHC; most of these are glasshouse growers. Horticulture advisers confirm that the courses completed covered topics on spray application, pest management, irrigation, including Farm Care, ChemCert, Pack care, Greenhouse Management Training, FreshCare quality assurance courses, business development, and a diploma through TAFE for the Recognition of Prior Learning. A Cambodian grower had received training through the Horticulture Centre for many things and advised others that if "you talk to people, if you know this, you grow better food" (34:37). Another grower, also of Cambodian background, confirms that he appreciated the training through the VHC on greenhouse management and Chemcert (40:24,26). The Vietnamese valued the Recognition of Prior Learning because it lifted their confidence and status in the community (27:56). Two policymakers and the current manager, who serve on the Board of the VHC, confirm that the centre serves an important role in providing grower education.

In relation to general information, growers obtain this from a range of sources, although some established growers believe they do not need advice. In relation to horticultural practices, advice was obtained from a consultant or agronomist, by calling at the Virginia Horticulture Centre, or South Australian Research and Development Institute (SARDI) (29:40; 30B; 40:28 and others). For information relating to water quality, growers confirm that they would contact WRSV. It was also noted by a horticulture adviser that all growers pay a levy to Horticulture Australia and have access to reports and general information, but it is doubted that they access it or read it (58:19).

4.4.4 WRSV service

The BOOT scheme operator, WRSV, have a shop front in the centre of Virginia, which is easily accessible to their customers. They are responsible for delivering reclaimed water and maintaining the VPS from the point where it leaves the Bolivar WWTP. It was established in the interview with the United Water Bolivar WWTP manager, that there is a good working relationship between the two entities. The plant manager will notify WRSV if a problem arises in maintaining water quality and to warn of possible interruptions to supply so that, if necessary, major customers can be kept informed (32:22). WRSV assist by keeping the manager informed of anticipated changes in demand to aid in the smooth operation of the DAFF plant. Additionally, United Water provide their specialist services when required in the event of a pipeline failure (32:28).

Seven growers referred to the service provided by WRSV and four are very satisfied (9,14,42,56). It is reported that WRSV are very responsible and committed to SA Water on sustainability (14:13,55); they respond to information needs straight away (42:60,62); there has only been a few breakdowns and, on the whole, the service has been good (9:37; 55:18). It was also observed that WRSV are flexible in relation to using water in excess of the contracted volume.

The dissatisfaction expressed by the remaining three growers relates to communication. One producer claims that he receives mixed messages from the company and it would be "helpful to be told about modifications to pressure" in the system so that growers can avoid damage to their pumping equipment (51:79). Two glasshouse growers have requested reductions to their water allocation, which equate to a transfer of water. Their complaint is that they have not heard back after a couple of years. The apparent misunderstanding could relate to a language barrier. One grower believes WRSV will let him know if they find someone else to take the water, and another is under the impression that he could adjust the quantity of water after only one year. The contract allows for transfers for all or part of the entitlement of water from one contract to another property within the irrigation area, providing (a) the customer to whom the water is to be transferred meets certain conditions and is approved by WRSV and (b) that the transfer

does not affect the stability of the pipeline system (WRSV 1997:4). It is not clear whether WRSV would identify a potential customer to effect the transfer.

4.4.5 Impediments to take up of information

Available time is the biggest impediment for growers in the take-up of information according to most responses on information and training. More than three respondents made the similar claim that there is a lot of infighting in the Virginia community but they manage to pull together if threatened by outside influences. It was also recognised that linkages needed to be built within the community involving all key players (21:24).

Several advisers suggest that a lack of trust in government proclamations hinders the transfer of information, while the WRSV manager reports that the company has a good relationship with growers when they understand it is a private concern:

> You know they sometimes think that we're a government department. And I think when they find out that we're not, they're a lot more relaxed. We've got a bit of flexibility; we try and understand their business. (2:152)

Historical influences on this state of affairs are identified and partly relate to communication. A policymaker locates the problem in the lack of government management of the groundwater creating scepticism of the government's intentions (24:20). An adviser explains that when meters were installed on bore wells, growers were assured the water would remain 'free' and that the meters were "just to keep an eye on the water; and then all of a sudden there's a quota put on, and then there's fines" (41:14). When the VPS was announced, another adviser recalls that grower perceptions were: "the bloody Government's got a problem and they are using us by making us use up their bloody rubbish water, and they are charging us too much for it" (21:16). The very presence of 'government vehicles' is enough to incite rancour, as explained by more than one adviser and growers. Unfortunately, this taints the identity of the VHC with some growers claiming it is a government-run concern. Another reports: "I don't think growers trust anyone" and that the growers' take on things was of others' "vested interests" and that the recycled water was being imposed on them (1:14, 54). Against this background, it is the view of one policy maker that the information transfer of reclaimed water was affected:

> It was a real inept public relations process on the behalf of the people promoting the scheme it need not have been as it was, but it was very, very badly handled. It was badly handled because there was a real lack of perception by those pushing the scheme as to where the growers were at. … I think that the people in the scheme assumed it was clearly a benefit when you've got an aquifer that's running out of water and growers wanting to use more water, that if you provide extra water it's going to be a plus. … The truth is that a huge proportion of the community didn't really certainly believe, and in many cases I think even know, that the aquifer is under incredible amounts of stress that it is. So, when this water as they saw it was being pushed upon them, all they wanted to do was fight the thing. (24:16,20)

Another factor relates to the cultural capital of growers who were raised in a school system based on the traditional top-down transfer of information. A horticulture adviser who has been involved in VHC workshops observes that during training workshops or seminars, few growers asked questions, keeping their heads down, so it was difficult to gauge whether they were taking in the information (21:8). He recommends a more participatory, interactive style of teaching and follow up to ensure practices reflect learning. Other advisers believe more follow-up is needed to ensure that the knowledge and guidance offered is implemented in management practices (27:68; 50:97; 41:26).

Cultural diversity

A total of twelve growers, eight with a Vietnamese background and four Cambodian, were interviewed. Of these, few claim to have seen any information relating to the VPS in their own language. It is confirmed by horticulture advisers that the Grower Manual was issued to all WRSV contract holders with a two-page summary of each chapter in Vietnamese (Appendix 4b). Therefore, it is acknowledged by an adviser that tenants of contract holders may not have received the information (58:17). A member of the VIA asserts that early information transfer on the scheme was "delivered in Vietnamese" (41:280). However, a member of the VFA affirms that the WRSV contract was not translated into Vietnamese (28:34). One grower understands the contract, while others recommend that it be translated.

It is explained that it takes too much time for people with a non-English speaking background to translate and understand English. For example: "They need to translate to give the grower. He has to have time to read" (34:35). The problem of growers having insufficient spare time to read material was raised by growers from a range of cultural backgrounds (see above). A member of the Vietnamese Farmers Association (VFA) believes that the best way to circulate information for Vietnamese growers is through brochures put out by the VFA and VHC, but they needed to be handed to people. Also, the VFA put out a weekly newsletter, which is popular.

That language is an issue was confirmed by several advisers and business people. A Vietnamese proprietor also brings out a newsletter, which he distributes freely to his customers on a quarterly basis. He identifies product and management information and has it translated into Vietnamese. He and another adviser note that all the chemical labels are in English, which poses a real problem for people who have difficulty with the English language. He has noticed people from Mediterranean and Asian backgrounds struggling with the interpretation of information written in English. However, the proprietor expanded further, explaining that growers are shy or 'afraid' when they cannot speak English very well. They may be able to have their question understood, but they usually cannot understand the reply or explanation given. Even he has difficulty with this situation. He made it clear that he would like to publish information about reclaimed water and that he would like to have a map of the line so that growers can identify whether they are located near it:

> They ask me and I don't know which way to go. … I need to let my customer know if they don't have enough water they can use it. (39:2-3)

Horticulture advisers observe that the Vietnamese are keen to learn and value the material being translated. The Cambodians too are learning the value of information and training after being encouraged for some time by an interpreter to participate in courses run by the VHC. From 1993 until recently, a Rural Solutions SA communications officer provided translating and interpreting services for enquiries made at the office, the courses run through the VHC and during negotiations for the scheme. In this way, PIRSA and Rural Solutions SA gave direct support to the Vietnamese and Cambodian growers. It was assumed that growers from Greek and Italian backgrounds would rely on their English-speaking children for translations (27:21). Currently, a part-time interpreter is employed as the need arises for the delivery of training courses. Both interpreters have provided support to the Asian community but their service has been hampered at times through cultural divisions within each group. For example, it is reported by three respondents that it is difficult for an interpreter from a particular part of Vietnam to earn the trust of both North and South Vietnamese and to hold that trust in the course of carrying out his official duties which may conflict with the interests of the growers (60;18;15).

Research conducted by Monash University (undated) on immigrant communities confirms that a bilingual project officer should be employed in communities where more than one language is spoken to "develop effective relationships with leaders and members of diverse range of ethnic groups" (undated:viii). They suggest that this could be achieved through the existing community groups, and individuals in order to

establish effective two-way communication between the growers and the Government (undated:ix,106:107). This underlines the importance of continuing the role of a translator and interpreter on a full-time basis.

Finally, there is an observed change in delivery of information and advice since PIRSA converted its government sponsored services to 'user pays' advice through Rural Solutions SA. Ten minutes of 'free advice' can be accessed initially, and then this is followed by a rate per hour for further advice. There has been a noticeable withdrawal of support services, including the full time interpretation services provided up until mid December 2004. All these moves have mainly affected glasshouse growers who either have difficulty with the English language and therefore may want clarification on instructions written in English; have come to rely on regular advice; are keen to undertake training; and/or who are new entrants to farming. The VHC sells several publications relating to soil and water management and chemical use in languages other than English (VHC 2005).

4.5 Reasons for accessing VPS

There was some jubilation expressed when the VPS came on line. For example, a glasshouse grower remarks:

> For me, personally, it has been a godsend. If I didn't have 'Bolivar water', I wouldn't be growing anything. It is hard to get a bore water quota. (9:37)

For various reasons, other growers thought it was "excellent" or were "delighted" and another said he exclaimed: "Thank God!" A government horticulture adviser working in the area at the time also confirms this response and explains:

> Most people were delighted to have access to more water. It gave them added security, and they were able to develop more land, as they knew they could extend their production. Some growers had moved out of the region to the Riverland and South East as they could extend their growing seasons due to water availability there. (27:28)

One broadacre grower interviewed by *The Grower* newspaper at the time remarked that:

> They wouldn't have gone ahead with this scheme, spending millions if they thought the water was going to be border-line so they're pretty sure its fit to be used to grow produce. (Washington 1996:6)

An adviser reports that despite "concerns about water quality" and "suspicion about salinity, the smarter growers were in there very quickly" to obtain significant volumes of water (21:42). Another observes "some saw it as an opportunity to increase or secure their production … it gave them a level of security" (27:30, 58). However, there was some initial hesitation in connecting to the VPS. Prospective users remembered earlier negative experiences, which dampened their enthusiasm:

> Back in the early 70s when there were trial plants growing, a few of the growers were connected to that green water and they had quite a few problems. Well, the rest of us were quite worried that we'd get it as green water and not filtered water, and none of us wanted to stuff up our properties the same way the trial did and a few others unfortunately. So we were all scared. (30C:84)

The Class A quality reclaimed water helped allay some of these concerns. However, it was recently reported that there is underlying uncertainty in relation to the market:

> Some growers using reclaimed water did not want to be publicly associated with it because of concerns of possible market place repercussions. This grower perception was still prevalent despite the community, grower and wholesaler (buyer) education undertaken prior to the commissioning of the VPS.
>
> (Kelly and Stevens 2001:3)

A Cambodian grower explains that he stresses the benefits to counteract uncertainty:

> Some people I know argue we should not use the water. I say [to them]: 'Sit down and we will work it all out. The costs may be low and good for the environment and it is a good income.' (46:36)

4.5.1 Connected to VPS

Almost half the VPS growers connected to the scheme did so to access a greater volume of water. This confirms an adviser's observation that growers were more concerned about "getting more water and expanding production" than price (27:62). Most of these (63%) are broadacre producers who struggled with the declining capacity of their bores. One of them explains:

> Virginia lacks water. It is the biggest limiting factor: the water table and the bore water … Bolivar [Class A reclaimed water] was better than pumping out of the ground. (35:15)

Others (five) needed the new source to replace the 'channel' or 'green' water because it was too salty and had restrictions on the use. Two perennial growers had no access to any water source at that time. Another reason given for connection related to water quality. Again, the majority are broadacre growers who report that their bore water was too saline.

Security of supply that allowed for expansion was identified by three broadacre growers. Another three glasshouse growers previously relied on mains water and therefore reclaimed water was a much cheaper option. Conversely, a broadacre grower was put off by the price and delayed his connection because of a limited need for the additional supply (30E). Currently, it is reported by WRSV and an irrigation business in the town that glasshouse growers represent most of the recent new entrants to the scheme who have no bore water allocation.

4.5.2 Not connected to VPS

Half of the 12 growers interviewed who were not receiving reclaimed water, were interested in connecting to the scheme. Each one explained that the reason for non-connection was because the pipeline did not extend to their properties (20:15; 26:2; 37:2; 41; 43:13). The fairness of access was questioned, particularly in relation to Angle Vale growers missing out and subsidies not being available to extend the pipeline to locations within the Virginia area. A member of the VIA explains:

> Some missed out. We had so much money in the kitty and the scheme stopped when the money stopped. … The route it took was the optimum route. But we were limited. Everybody had the opportunity to put their hand up, or did not, and that is what determined our route. (44:393)

The range of reasons for wanting to connect is similar to those already outlined, that is:

- Access to water — Can not obtain a bore water quota
- Additional source — To increase supply
- Cost effective — Cheaper than mains water; cheaper than pumping from a bore
- Water quality — Existing bore water too salty
- Conservation — Of existing bore water supplies

On the other hand, each of these prospective users of reclaimed water express some reservations about a future connection. These centre on the cost and contractual requirements. In relation to cost, one grower notes that the water works out to be double the cost of bore water (30:237D) and another could not afford to pay for the extension of the pipeline to his property. With respect to the contract, two growers believe it is difficult to estimate allocation requirements; you have to pay for your allocation up front, are charged more if you go over your allocation, and charged fees if you want to transfer the water (37:12). A Cambodian glasshouse grower evaluates the situation as he sees it:

> The way the contract was worded was a bit shonky and that they need to be more flexible. … They designed it as a cost recovery to them. … They did not see it as a sustainable measure that would support growth. If they saw it as part of economic development they would be more flexible. If it is a benefit - to enable this industry to benefit - it would be sustainable. (37:14)

There are many more Vietnamese and Cambodian growers who are interested in connecting, according to a local businessman. However, he explained their reluctance to do so:

> They are afraid to pay for what they don't use. … My opinion is we happy with the result in the Bolivar Water but we need to know what is in it and how salty and all that. (39:2-3)

Reasons for the remaining six growers for not connecting relate to and expand on these themes:

- Access to water — Already has alternative sources of water
- Additional source — Have sufficient bore water
- Cost effective — Bore water is cheaper; too costly to connect to the VPS
- Water quality — Salt levels of reclaimed water are too high for hydroponics; quality cannot be guaranteed
- Contract — Too difficult to estimate future requirements
- Inconvenience — Two many other problems to sort out (a broadacre producer)

4.6 Water quality

The initial understanding and perceptions of reclaimed water quality centred mainly on public health issues. Then, during the first twelve months, growers report that they did experience teething problems with the water such as algae in their storage tanks and dams that caused clogging in their sprinklers (13:19). Occasionally, the water was not delivered due to the water not meeting quality standards. One broadacre grower notes:

> In the first twelve months you could have had a bubble bath in it. There was that much soap [phosphorous] that it frothed up. There must have been an outcry from the growers about this because within about twelve months it had completely disappeared. (56:8)

The WWTP manager explains that in the early years difficulties were experienced in getting the Programmed Logic Controllers (PLCs) to work properly. They are the 'brains' of the Supervisory Control Data Sequence (SCADA) system that allows operators to control and monitor operations and switch to manual if there is a concern. The problem was eventually diagnosed (32:14-21).

Of the 24 growers connected to the reclaimed water 80% referred to water quality. Nearly half (9) of these are satisfied with the water overall. One broadacre grower generalises that "on the whole, everyone is delighted with it" and another asserts:

> It is world-class water. We can use it to produce vegetables and it hasn't killed anybody. (56:18).

Another claims that he is "happy with it and when something is good, you don't look at it too much" (62:2). A glasshouse grower reports:

> Some people still complain about this and that thing. But it is good, it depends how they grow. You've got to know what to do. (34:31)

Other positive statements related specifically to quality of produce, which indirectly exemplifies water quality. A glasshouse grower confirms that his produce is good and he has no complaints (9:13). Another glasshouse-perennial grower says he does not grow as much produce as he did previously, but is enthusiastic:

> The reclaimed water is the best thing that ever happened to Virginia. … It might be best thing ever happened to South Australia. We will probably need to drink it, what do you reckon? We will, but maybe not for 30 to 40 years. (47:5,6,7).

Three growers compared produce grown with reclaimed water to other sources they either used previously or source on other properties and confirm that there is no difference between them (53-G2; 45:56; 51:98). However, others are concerned about the effects on produce. An adviser who works with the Vietnamese community reports that growers are worried about chemical elements, they "don't know what is in the water" and whether it will affect their plants (28:16). He claims that some, who are connected to the scheme, do not use the water because of this (28:16).

For most growers, their assessment of reclaimed water quality focused on salinity. Concerns around nutrient levels in the water were also mentioned but not in great detail. The quality of the reclaimed water in relation to public health is generally accepted as meeting the standards set by the providers and regulators. The experience of all aspects of water quality brought to the attention of the researchers is presented under the respective subject headings below.

4.6.1 Public health

Initial concerns

When the scheme was being implemented, the main concern was how reclaiming sewage effluent to irrigate food crops would affect market acceptance. This 'unknown' effect was addressed by ensuring that the water was treated to the highest quality for horticultural use. A broadacre grower earnestly reflects:

> The emphasis was placed by the growers to say: 'Look, we've got to sell our produce to the market place so it's actually fresh …' And there was no choice: it was either Class A or we didn't take it! (30F:91)

Class A reclaimed water was developed to the satisfaction of the Department of Health for irrigation of food crops. The key adviser from the Department reports:

> There was a long involvement from the Department in undertaking the risk assessment and the potential viability of the scheme, so that in principle approval could be provided before construction commenced, and then we provided a formal approval relating to the public health issues related to the scheme. So, in the case of Virginia, we provided two approvals: one to SA Water for the operation of the treatment plant; and one to Water Reticulation Services [Systems] for the distribution and use of the reclaimed water. So, quite a long involvement with that scheme, and in most of the complex Class A schemes it would be a similar level. (6:2)

The general parameter for Class A reclaimed water is set out in the South Australian Reclaimed Water Guidelines (1999: Table 1.1, p.7), as follows:

Microbiological criteria	< 10 (therm. coliforms or *E. coli*) / 100 ml (median); specific removal of viruses, protozoa and Helminths may be required.
Chemical/physical criteria	Turbidity ≤ 2NTU; BOD < 20 mg/L (≈ 30 µS/cm EC); chemical content to match use
Typical treatment process	Full secondary plus tertiary filtration plus disinfection. Coagulation may be required to meet water quality requirements.

For unrestricted crop irrigation from the Bolivar plant for the VPS, the Department of Health defined the parameter for pathogens as <1/50 L (objective zero) and turbidity <10 NTU (mean), 15 NTU (max) (Thomas 1999:7). The WRSV manager confirms "if the water ever goes out of spec on the health side of things we don't receive it at all" (2:96).

The VHC coordinated a group to develop a risk management strategy when the pipes were being laid to address negative perceptions associated with the use of water sourced from sewage effluent (60:67). The group comprised the Playford City Council, the EPA and the Department of Health (60:76). A CSIRO adviser and the Department of Health talked to major retailers and wholesalers:

> We spoke to them all, so they know about the controls. … We had no problems at all. In fact, a lot of them weren't interested. It didn't bother them because … everything that goes through the Pooraka markets goes through a quality assurance program. (6:19, 25, 29)

There was little confidence in canvassing public opinion. A horticulture adviser admits:

> We had no idea what the consumer perception of that stuff was going to be and we had to feel our way and so we chose the reactive approach. It is always something that restrains reuse because it's unknown and it would be nice to know what that unknown is. (1:24)

The 'reactive approach' refers to another VIA strategic committee that agreed to meet as a matter of urgency whenever negative feedback on water quality was received from growers or the market place. A member of the VIA recalls that when a complaint was made the committee ensured that the right information was provided within 24 hours. This was achieved by seeking advice from experts from CSIRO, and PIRSA to sort out the problem. It is said that they only met three times, and each concern

raised had nothing to do with reclaimed water (30D:102). An adviser confirms the problems related to "just general good practice, leaching the soils" (1:46). This strategy, rather than wider public consultation, was preferred because of the perceived sensitivity of the situation:

> We talked to wholesalers, we had a communication strategy in plan, so that if anything bad was said about recycled water we could go out, find out what it was and get the facts out there. So perhaps very reactive on that side of things, not very proactive. And I think I've always thought that that was the right thing to do at the time because it was the first one in Australia, it hadn't been proved, and we didn't want to go and make a big thing of it in the press. We wanted to get the hard proof first and then we could talk about it in the local media. (1:42)

One of the growers that helped establish the scheme believes that public perception was not an issue because his impression was that it is generally accepted:

> I think the key thing too is in South Australia the public were for it, we didn't have to convince the public to use recycled water. … and some people that I was talking to said: 'I thought you'd already had that in there, why is it taking so long?' So it was actually quite positive. (41:274-6)

Therefore, when commitment to the scheme was being firmed up growers recall that, rather than public perceptions, it was the negative perceptions of some of the growers that threatened the smooth introduction of system. Two respondents independently claim that the water was referred to as 'poo water'; for example:

> In the early days, we had a small number of people at the meetings – no matter what you did they would not accept it. Some old [ethnic group] did not want it in the area at all. [To them] it was 'poo-poo' water. (13:45)

Early negative reactions were recalled by others with amusement, as some of the early opponents later connected to the scheme. This broadacre producer vividly remembers:

> There were a lot of negative people in the crowds. 'Everybody would be dead from cancer in 15 years!' 'You will poison the underground basin!' (56:39)

A glasshouse grower explains that the idea of labelling the produce was raised but not followed through:

> Well, in the early stage, we had people saying we had to label our produce to show we had used reclaimed water. But that idea went away. (9.45)

Current opinion

Most growers interviewed are confident that Class A reclaimed water poses no health problems. Several report that reclaimed water cannot be used to wash produce and there is no indication that these use rules are being violated. One broadacre grower is very clear in pointing out that the Health Commission checks the water supply and that it must not be connected to the packing shed (44:159). A Cambodian grower confirms this health restriction:

> No, we don't wash with reclaimed water. We must hose it off a little bit but we use bore water to do that. Reclaimed water goes straight to the dam and from the dam straight to the paddock. … We don't even use it for the house – just the lawns – its not allowed to go into the house. (46:9-10)

An established producer is concerned that some of the new growers to the area have been drinking the water (13:41). However, a member of the Vietnamese Farmers Association explains:

> They just put it on their lips or smell it to see how salty the water is [bore and reclaimed water] before they put it on their plants. They want to see what chemical elements are in the water. (28:24)

One horticulture adviser expressed concern that a working group has not been established to devise a strategy to ensure irrigators comply with legislation on their use of reclaimed water (21:54). One of the hydroponics producers has experimented with reclaimed water shandied with bore, rain and/or mains

water, but only uses it as an emergency back-up. While it is generally known that reclaimed water is too saline to use in hydroponics (several growers state this), there is no link made with public health concerns. The Grower Manual confirms that the South Australian Reclaimed Water Guidelines do not specifically cover hydroponics and that advice should be sought from the Department of Health, the EPA and PIRSA. An information leaflet circulated through the WRSV office and a QA adviser simply states that reclaimed water will require further treatment by reverse osmosis or an equivalent process authorised by the Department of Health.

Information provided produces mixed reactions in relation to public health concerns. For example, one grower states that although Class A reclaimed is suitable for water sports, he will not be swimming in it: he believes he is already exposed to that degree when he checks the sprays (51:179). He was also concerned because he thought he had received a letter from the Government advising that gloves should be worn (51:180). However, after retrieving the information, it was in fact the VPS information leaflet that reflects advice in the Grower Manual: "wear/use clothing and equipment appropriate to tasks being undertaken" (p.14). Similarly, on reviewing the VPS information handout a wholesaler comments "it's a bit of a worry if you have to wash your hands after using it" and: "Why does it have to be separated from septic tanks?" (7:21).

The current experience of maintaining water quality to protect public health was described by the WWTP manager. He works closely with the Department of Health and is impressed with the key adviser there who is well known to the water industry:

> [Name] is extremely pragmatic and he is good value to deal with. This is important for us. … He is very sensible. … But he draws certain lines in the sand and he won't shift them. He will have his reasons and he won't shift. One of those is to combat the risk of *Cryptosporidium* passing into the water supply. The water has to be in the lagoons for 16 days before we take it up. (32:62)

However, there is a measure of discontent, as expressed through one grower, over SA Water's contribution to the VPS with respect to investment in improving water quality. It is understood that because the Bolivar WWTP went through over a hundred million dollar upgrade in response to the public outcry over the 'Big Pong' (an odour event at the WWTP in 1997), that: "the $17 million that they spent for that DAFF was a waste of money" (44:325).

Therefore clarification was obtained from one of the DAFF plant consulting engineers on the role of the DAFF plant. It was explained that Class A reclaimed water that satisfies the stringent Californian Title 22 standard is difficult to achieve with algal laden effluents. The Bolivar Class A reclaimed water is produced at consistent quality, firstly through the retention time of the effluent in the lagoons which, in the case of the Bolivar WWTP, follows the BNR denitrification treatment. The lagoons achieve the removal of pathogens through detention, sunlight and microbial predators. They also provide a buffer to minimise water quality deterioration arising from abnormal industrial waste discharges. However, in the process, there is a build up of suspended algae and the DAFF treatment is the best process for removing high loads of suspended algae (66:15).

Two growers provide information on market reactions. A broadacre grower confirms that no one has rejected his produce because he uses reclaimed water (44:194-5). Another reports that although he has not heard any negative feedback from the market, a marketeer claimed that one grower's produce did give off an odour when stored for three days (45:273, 281). This claim was put by the researchers to advisers and a well established grower of the same produce. It was confirmed that, firstly, any produce would smell if kept too long in storage; secondly, that the crop may have been picked during a heat wave which would hamper its keeping qualities; or thirdly, the produce may have been rotten before it was refrigerated. The established grower had not experienced the problem himself, suspected wholesaler-mischief, and was

keen to do a trial, storing the produce for two weeks, rather than three days, to prove there could be no link made with reclaimed water (44:183).

Advisers confirm that adverse publicity and public health events also affect perceptions. A marketing consultant working in the region reports that no adverse comments have been heard about reclaimed water with respect to the market. However, the consultant claims that recent incidents of Bovine Spongiform Encephalopathy (BSE, or 'mad cow disease') in Britain ignited concerns amongst growers, especially of Asian origin. Growers have been heard to say that they are concerned that somewhere 'down the track, pathogens can be transferred to humans' and there is uncertainty of the extent of pathogen transfer (22:3). A horticulture adviser is concerned that no marketing strategy has been developed to achieve a positive perception of reclaimed water in the mind of the general public. It is believed an overseas competitor (for example, the French wine industry) may use knowledge of reclaimed water being used on vines to raise a potential health threat and damage the overseas markets (21:54).

Wholesalers

Wholesalers do not appear to discriminate between produce grown with reclaimed water or any other source, however, there is a degree of uncertainty, some reticence and concern expressed in relation to public health. All seven wholesalers interviewed confirm that they receive produce grown with reclaimed water; the lines they carry are listed under the earlier demographics section. These are not identified with individual responses to ensure anonymity. Two who provided short statements, indicate Virginia produce comprises a small proportion of their stock, with one claiming only 2% of his produce comes from Virginia and another advising:

> Most lines I buy are not affected by the Virginia Pipeline Scheme. I buy very little from Virginia. I have had very little to do with it. (16a)

A vehement report was provided by the other wholesaler who receives minimal produce from Virginia. He buys mainly from Melbourne because he says they are professionals compared to the local growers and adds:

> In summer, the stuff that comes from there is absolute crap. It's also because of the salty Bolivar water, and it stinks. Their land stinks. I know because I have got land there. (16b)

Yet, it is noted that none of the 36 growers interviewed complained of odour, nor was it detected on any of the forty-odd days research was undertaken in the field.

One wholesaler also has land at Virginia and grows produce, but at a diminishing rate. He attended a VPS information meeting but decided he "would not use it" because they could not "guarantee the quality of the water … they said you have to mix it with bore water" (8:5). He is quite firm that it has to be diluted and that it is "no good for brassica's" (8:7). He claims the water left a "white powder film" on capsicums and that it wasn't due to salt because "the bore water is saltier" (8:13, 15). However, his observations relate to the initial period the scheme came on line. He also believes that produce grown with reclaimed water "should be labelled on the box" because "some people are funny about that" (8:20). It should also be restricted to drip irrigation for brassica's or otherwise potatoes, onions and carrots because "the ground acts like a filter for root crops" (8:18). He expressed a general distrust in science and asks:

> What is its long term effect? What build-ups are there? … What if they make a mistake? If someone gets sick and we get the blame for it? It will be very hard to find if its reclaimed water. (8:24, 47)

Nevertheless, this wholesaler trusts his QA adviser and growers. He was keen for the researchers to follow up both his QA consultant and a Virginia producer who uses reclaimed water. Both were interviewed and their responses are included in this report. For the long term, this wholesaler would like to see more research conducted in relation to the shelf life of produce grown with reclaimed water. He believes it is "a lot shorter because it grows too rapidly" (8:49).

Another wholesaler/grower is very positive about the use of reclaimed water and uses it "straight" on one of his properties. He has bore water on another property and prefers reclaimed water because bore water has "too much salt" (34:19). He buys all local produce except for some special lines and places a great deal of confidence in his QA system and adviser. All his growers must comply with SQF 2000 standards. By contrast, two wholesalers also own property in Virginia but stopped growing when the reclaimed water came in. They both give assurance that the decision to stop growing had nothing to do with the VPS. However, both have unanswered questions in relation to health effects. One wholesaler asks:

> How good is it treated? Is it treated only 50% just because it's for plants? Do the roots break it down? (7:4)

However, he was not aware that the Department of Health specifically approved the quality of the water. He is impressed with his QA adviser and in relation to produce grown with reclaimed water he confirms: "I've heard no real complaints coming out of it" (7:12). The other wholesaler doubts:

> As much as they purify the water, there is still got to be metals – heavy metals and other things. … They are supposed to mix it with bore water. I don't know if they do mix it. (10:1,3)

His produce is mainly sourced locally but he states that the quality and presentation of Virginia produce is not as good as elsewhere, but hastens to add: "not because of the reclaimed water" (10:15). Finally, this wholesaler claims: "Overall, the quality is pretty good here compared to other states" (10:17).

A seventh wholesaler asserts that there is no difference between produce grown with reclaimed water and other water sources. He adds: "But a lot of people mix it with the mains water" (11:3). Further, he reports that his friend uses it and his "crops grow well" (11:9). A large wholesaling business manager also states: "I haven't found any difference at all" and one of his major lines is grown with reclaimed water. He admits:

> When I first heard [about the reclaimed water scheme] it was a little bit of a shock, and everyone was a little bit afraid about it. The product may not have performed as well as normal water. But where we are at the moment, there is no problem. (33:4)

He reports that they have accredited growers and that his company conducts "a couple of hundred tests a year – these are our own tests and each of them has to comply with it", to follow Hazard Analysis and Critical Control Point (HACCP) standards (33:13). He adds: "I have not heard any grower that bagged it. Initially, when it first started – the pipeline - we heard a lot of it [concerns]" (33:33).

Finally, another wholesaler, who has been in the business for two years, buys mainly from Virginia and has "no problems" (12:7). When asked about QA he replied: "I trust my growers. They get checked – mainly on the farm" (12:9). However, he has concerns in relation to the long term effects of reclaimed water on the land:

> I know it is completely different than normal water. After a period of time there might be a problem and they should test it more often. (12:11, 29, 33)

He concludes: "Personally, I don't believe in this water" but as far as vegetables grown with reclaimed water are concerned: "The produce is no different from Virginia than anywhere else" (12:33, 39).

Retailers

Two major retailers were approached and supplied a written policy statement from their head offices and did not think it was necessary to be interviewed. The policy statements are set out below.

> Woolworths' position in regards to the use of reclaimed water is such that we are supportive of its use particularly in respect of the severe drought conditions experienced in recent times. The only qualifier to this statement is that we do require that the water provider be able to verify the quality and food safety of the water used in respect of MRL's, Heavy Metals and Microbiological components. It would be pro-active to have any allowances clearly documented to allow for product testing and auditing of any standard set.

(8 December 2004)

The second major retailer provided the following statement:

> Coles Myer accepts the use of reclaimed water for irrigation purposes although where reclaimed water is used it shall only be obtained from an EPA and Department of Health approved/registered agency and it must be of a class suited to the application/purpose. Documented evidence of the class of water supplied and its appropriate uses is also obtained. Substantial review was undertaken in relation to reclaimed water although there was no market research undertaken directly by Coles Myer. (18 January 2005)

Quality Assurance

In-depth interviews were conducted with two major quality assurance (QA) assessors who are engaged by wholesalers at the Adelaide Produce Markets to carry out audits on growers' management practices and produce sold at the Market. When QA assessors first learned of the VIA, they were worried and this resulted in a thorough-going scrutiny of the risks involved, for example:

> Initially, when we first started we thought: 'Oh gosh, this is going to be a problem.' And we all panicked. We did that much testing and found no issues that I'm really not bothered at all. And the reclaimed water is so well controlled by SA Water. They do that much testing – because we went down this path, don't you worry. Because I had all these auditors from interstate coming in and being so worried about what was happening at Virginia. So I had to get all this paperwork to prove to them that it was safe. So I've got lots of information on a lot of the water testing that they do, the methods that you can use. Because you can't use it for certain processes. You can't wash with it for example. You can only irrigate. (3:48)

It was explained that the QA consultants follow up each new grower:

> We have to make sure that they have got some form of a quality assurance program in place, and we normally test the first product that comes through the wholesaler at Pooraka. And then we test it every year after that. … Some, more. (52:17, 19)

And the other assessor explains that each new grower is automatically contacted and farm visits and testing follows (3:16, 20). As yet, a comparative analysis of test results on produce at the market is not made between growers based on source of water. However, one QA adviser is in the process of setting up a database:

> So next to every grower's name I'll have all the information from our farm visits and the type of water they use and chemicals they use. I'll have all that and then I'll have their test result next to their name, then I'll be able to link in, but it's on paper at the moment. (3.70)

Reclaimed water is not singled out as a source of concern, because:

> Part of quality assurance is making sure that water, like any kind of water they use, doesn't contaminate their produce. So we look at all kinds of water. So whether they use dam water, rainwater, river, mains water, bore water or reclaimed, we still have to do the same hazard analysis, the same risk assessment. We need to look at the way that they store water. Where it comes from, any contaminations. (3:4)

And, in relation to testing water quality as routine practice, the other QA adviser explains:

> The grower is supposed to test the water once a year if he's got a quality assurance program in place. [Tests are for] usually micro-organisms. So, you're probably looking at things like coliforms, faecal coliforms, *E coli* - that sort of thing. (52:25-27)

The VPS guidelines (referred to as the 'DAFF guidelines', nine photocopied A4 pages – now the WRSV information leaflet) is used as a 'checklist' when one assessor goes on farm visits 'and water is part of that entire checklist' (3:22). It was further clarified:

> We really just use those DAFF guidelines because the HACCP program and the Wooloworths standard and all those things, they say that you must do an assessment, a risk assessment, and water is included in that but

> they don't specifically say you must use a particular kind of water. They are never that specific. They leave it up to us to assess the risk and then the auditors come in and check whether we've done that assessment correctly. (3:32)

However, a horticulture adviser reports that QA auditing groups are now incorporating aspects of reclaimed water into their training courses. Food Safety Australia will shortly be publishing a document to cover this information (1:88).

It was also claimed that SA Water (or the DAFF plant operators, United Water) makes water tests available "but we haven't needed to [obtain them] because we're doing our own testing":

> So we do testing not only on water but on produce. More so on produce than on water. We find that by testing the produce we are cancelling out a lot of scenarios. Because you can have good water quality but still have contaminated produce from other sources so we'd rather test the finished product and then work back to work out the source of contamination. (3:54)

Wholesalers carry the brunt of the backlash if a grower's produce does not meet standards, for example:

> I mean Woolworths do their own testing as well, they're not stupid, and if Woolworths finds something, then the wholesaler gets left out. It might only be for three months, but that's a lot of money. (52:123)

Finally, it was confirmed that few problems have been detected across all the produce tested. One assessor states:

> We have really good results. … Through the testing program I think its about 98% - 99% compliance so its really high for the quantity that we do. (3:58)

The other assessor reports that since the VPS came on line in 1999 the volume of testing has gone up:

> I guess probably we actually test more than we used to – the produce – for chemical residues and microbe – each of which have got limits that we've got to adhere to. … But I haven't found any problems with the testing. The figures don't appear to have changed when we were doing the testing before the reclaimed water was used to after. (52:2,5)

In addition to QA advisers, a soil specialist reflected on health aspects of produce grown with reclaimed water or under conditions where gypsum is applied to negate salt in the soil (see under Salinity below: Crop effects).

4.6.2 Salinity

Growers are guaranteed water quality of <1500 mg/L TDS (≈ 2340 µS/cm EC), negotiated with growers during the development of the scheme. Salt levels or salinity was mentioned by three quarters (18) of the growers connected to reclaimed water. Some state that they know the DAFF plant monitors 24 hours a day for salinity (56:26) and reclaimed water is diluted at the plant with mains water to maintain the salinity levels particularly in the summer (42:123). Several growers specifically understand that it should not exceed 1500 mg/L (≈ 2340 µS/cm EC; 30B; 42:123; 56:26, 44:262). A well established glasshouse grower believes the suppliers are encouraging extraction of reclaimed water in winter to store for summer use and that this might improve the salinity levels which are lower during winter (42:123). An adviser confirms that salinity increases during summer months (27:51).

It is confirmed that the guaranteed salinity levels apply to the reclaimed water as it exits the DAFF plant "but they can't guarantee salinity levels at the point of delivery" (27:39). Although groundwater of salinity "less than 1,000 mg/L (≈ 1560 µS/cm EC), is often targeted for use by irrigation" (DWR: undated b), a third (8) of the growers connected to the scheme do not have an issue with the salt content of the water. They explain that it is either not a problem (25:8; 34:2); is at a reasonable level (55:2); is less salty

(40:10), or at the same level as their bore water (44:267); that the salinity did sometimes fluctuate but was usually consistent (38:82); or that any salinity problems will be worked out by the engineers (14:39). And another grower relates that before the reclaimed water came on line, he had to shandy his bore water and irrigate "at night to reduce water salinity. Then Bolivar water -Yipee!" (35:17,18).

However, another third (including two of the above) would prefer a reduction in the salinity levels (9:37; 29:44; 14:40; 38:6; 42:28; 19:12), particularly in the summer months (29:10). For example, although one glasshouse grower is satisfied with the water, he adds that "they could make a few improvements like lowering the salinity levels" (9:37). Two of the growers in this group had also heard of others having problems with salt (19:47; 42:109). One glasshouse grower is considering moving to hydroponics due to the current salt accumulation in his soil (38:100).

Crop effects

Different experiences are related to the effects of salinity levels of the reclaimed water. A quarter of the growers made the following observations, complemented by advice from other respondents, and one horticulture researcher has observed no problems with reclaimed water (65:1).

An established Cambodian glasshouse grower believes that the salt makes the fruit taste better but it does not "look as good" (29:61). The taste of Virginia produce was raised by two wholesalers who claim that it tastes better than Melbourne imports (7:43) and, for one, this was more important than appearance:

> What is more important, the appearance or what's inside? I go for the taste not what it looks like. (12:13)

A recent spike in the salinity level of the water had been noticed by a broadacre producer as it was reflected in the appearance of his crop. However, he advises that this is rarely an issue (45:68,72). The spike was raised by the WWTP manager, who takes United Water's obligation to maintain the salinity level below 1500 mg/L (≈ 2340 µS/cm EC) very seriously, for example:

> We had an issue with salinity for another reason and we were in a position to tell them in advance what was coming up. Our view is that it saves them embarrassment if the farmers come in - as they pick them up [the spikes in salinity levels]. Salinity was running from 1100 to 1200 to 1500 [mg/L] [≈ 1720 to 1880 to 2340 µS/cm EC]. 1450 [mg/L] [≈ 2270 µS/cm EC] we were giving them. The farmers noticed it, and I only did it for three or four weeks and they picked up the difference! Luckily we had spoken to [name; WRSV] about it [beforehand]. (32:25)

Specific effects are reported. A glasshouse grower states that he tried to grow cucumbers when he changed from 'channel water' to Class A reclaimed water, but "they die soon" (19:18). He is also experimenting with the use of reclaimed water for olive trees and pointed out dead twigs and what appears to be a ring of salt on the ground surrounding each tree (19:12). Another two glasshouse growers claim that reclaimed water is not suitable for cucumbers (29:10; 38:18; 40:22), with one reporting that he stopped producing when they turned yellow and caused problems at the market (29:10). A well established grower and wholesaler explains:

> That is not reclaimed water. It may be the way they apply fertiliser. Maybe it's not the right fertiliser. Reclaimed water for cucumber. For the first four and five crops - OK. After five crops they might have high nutrients and salinity. But only after five. (34:6-7)

The same glasshouse growers report effects on tomatoes. Two claim that their crops are able to tolerate the high salinity (38:18; 40:22); while another laments that his died (19:18).

In reply to growers who cannot grow cucumbers and tomatoes:

> It's to do with the management of sodium chloride. It depends on the soils types, there are some areas like for example, Buckland Park way and those places closer to the sea, … what they need to do is probably truck in better top soil, have it above their existing soil, well you can do that in greenhouses. (41:225)

A broadacre producer advises that growers need to look at their fertiliser programme, particularly if they previously used bore water, as the salinity is often the same (44:375). This advice echoes that given by another three horticulture advisers. One explains that salt interferes with the uptake of nutrients (50:32). In relation to Vietnamese growers, it is reported that they claim the salinity level is too high and salt can be seen on the surface of soils. However, the Vietnamese adviser claims: "If use fertilisers wrong, can also get salt too – so can't always blame the reclaimed water." (28:16). A government adviser also cautions that these effects are not simply due to the reclaimed water. "There are many influences – drainage, fertilisers or outside influences" (31:39). Another specialist explains that fertilisers contain salts; therefore soils must be leached (58:15). Yet another suggests the problem relates to the management of sodium chloride and soil type and in the case of glasshouse production located near the sea, better top soil should be introduced (41:225).

Based on growers' reports and field observations, one of these influences could be location of property with respect to salinity of bore water and water table levels that may either determine or exacerbate levels of soil salinity. Currently, salinity levels for the T1 and T2 aquifers vary from 500 to over 2000 mg/L (≈ 780 to over 3130 µS/cm EC), with less than 10% of monitored bore wells indicating levels greater than 2000 mg/L (≈ 3130 µS/cm EC; NABCWMB 2004).

During the data collection period, it was confirmed that United Water and Adelaide University are currently undertaking a project investigating the reduction of salinity levels in the reclaimed water (Heidenreich 2004). The research has shown that second feed and RO was the most cost effective, involving an extra cost to the grower of 33 c/kL to halve the salinity – improving the level from around 1200 to 600 mg/L (≈ 1880 to 940 µS/cm EC) on average (Heidenrieich 2004).

4.6.3 Nutrients

The level of nutrients is generally not a concern for growers with reclaimed water experience. A quarter of those connected raised it and two were positive comments. Two broadacre producers understand that nutrients are removed from the water by denitrification (51:91; 44:377). Another broadacre grower observes no difference between bore and reclaimed water in nutrient levels because: "I've actually had to continue my fertiliser applications at the same rate" (45:320). A horticulture adviser reports that phosphorous does not appear to be an issue; it has not been used much in Virginia recently and perhaps this may be because it is available through the reclaimed water (50:34).

However, a fourth broadacre grower has noticed a slight increase in colour of his crop although he has not changed his fertiliser programme (56:24). And a Vietnamese tomato grower explains that although he prefers bore water due to the lower salt levels, the reclaimed water has more nutrients and was clearer and clean (40:10). The hydroponics grower wishes that the water had "a full range of nutrients in there, suitable for hydroponics, then I would just use it by itself and it would be great" (42:101). The higher nutrient value is confirmed by a local businessman who sells less fertiliser to reclaimed water users:

> It seems to be they use less fertiliser. They tell me reclaimed water got a lot of nutrients in and that is why they use less. (39:28)

Covered storage tanks are sometimes used to control algal growth and a glasshouse grower believes that he has no problems with algae because his water is stored in covered tanks. Algae was mentioned by one wholesaler who reports that he noticed slime around the plant and dripper on one grower's property but "I'm pretty sure they have improved it." (7:2-4).

The WRSV manager confirms that there was algal growth in the early days. Problems with clogging of irrigation equipment and filters were overcome when the BNR upgrade of the WWTP dropped the nutrient loading by around 50% (2:122). An irrigation adviser reports:

> The main issue is storage and how to maintain the quality in the storage. The single biggest issue, because of the nutrient load in water, is it encourages organic plant growth and you end up with fairly murky dams when they have been left sitting for a while. (49:24)

Other advisers note that the problem is more evident in winter when there is little movement of the water. However, the irrigation adviser also observes that similar problems are experienced with bore water storage:

> They have always used dams with bore water and you did get problems but it tends to be growing out of the sand, at the bottom. With the Bolivar water, you tend to get floating long stringy stuff. (49:26)

It was further explained that the problem could be managed (see under Management Practices, 4.9).

4.7 Water supply and demand

There are different recollections of how much water needed to be committed before a decision could be made to build the scheme. The water retailer suggests that the figure is around 19 GL/a, while a member of the VIA claims that it was 17 GL/a. Either way, it was confirmed by a range of stakeholders that one large company, known as Seabreeze, had indicated they would take 4GL of water. However, Seabreeze pulled out of its commitment when it ran into financial difficulties, but by then the scheme was up and running. Hence, some stakeholders agree that the one producer that threatened to monopolise demand was in fact a blessing in disguise. Since 1999, the volume of water sold has steadily increased and WRSV expect to reach the original 19GL/a by the end of next year if the extension is completed.

The actual volume that is supplied is lower than that allocated to growers through contract sales. Based on information obtained from SA Water's representative and their website information, the figure currently lies between 14.5 and 15 GL/a. This is validated by other sources. From United Water data supplied by the Department of Water, Land and Biodiversity Conservation (DWLBC), it is confirmed that 14.5 GL flowed through the Virginia pipeline to growers in the year ended June 2004. The seasonal and monthly fluctuations in demand are illustrated in Figure 3. It can be seen that the driest months consume from 1.8 to 2 GL/month and this falls to 0.4 GL/month in the three winter months. When it reached a peak in December 2003, it was averaging 65.9 ML/d. According to a Bolivar WWTP manager, there are days during the summer when the DAFF plant almost reaches its design capacity of 120 ML/d. From SA Water's point of view, although the scheme has been a success, the volume supplied is still far short of the 30 GL/a originally targeted (5:20).

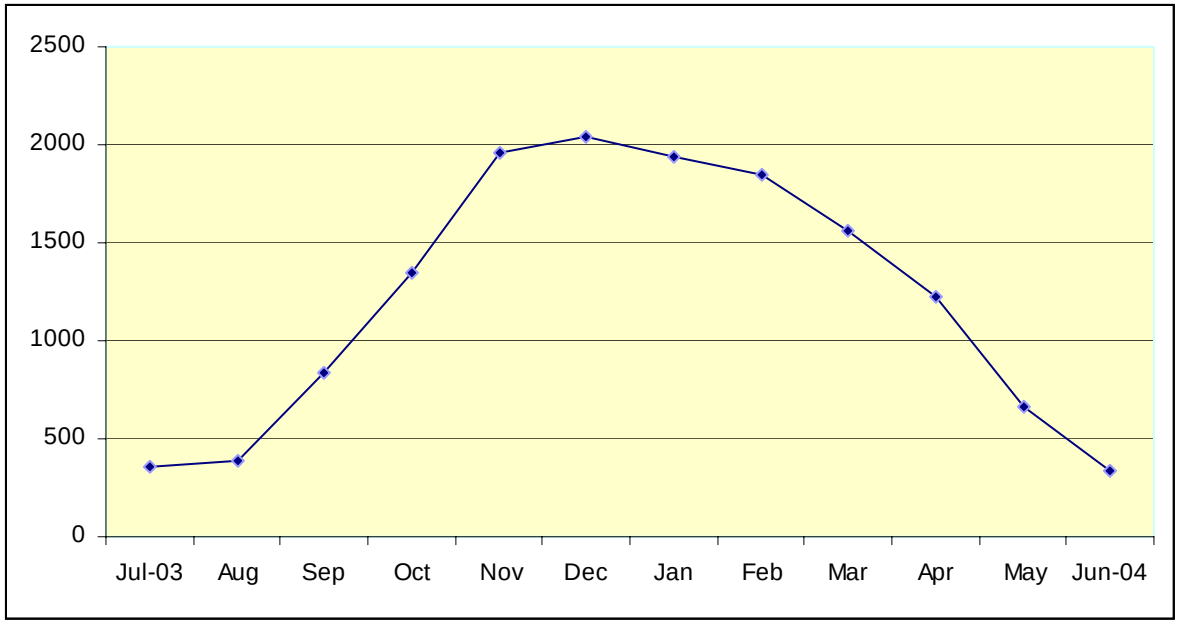

Figure 3 DAFF product water flows to Virginia (ML/month) 2003-4
Adapted from data supplied by DWLBC respondent, sourced from United Water International Pty Ltd.

A broadacre grower recalls that when Seabreeze was 'in', it was thought that there was not enough water to go around:

> Tyco were saying: 'We have sold all our water.' Great stuff! Everyone's dream! Demand outstripped supply! (35:19).

However, when Seabreeze fell through, growers were encouraged to over-allocate their water supply in order to reach "the 17GL limit" needed for the scheme to go ahead (44:380; 35:32). This encouragement came from proponents of the scheme, including growers. Over-estimating is also linked to the daily limit on access to annual allocations, as presented under 4.7.1 below. Of the 24 growers connected to the VPS, 20 referred to reclaimed water supply and demand, mainly focusing on access to their allocation of the water, the contracted allocation, and water transfers.

4.7.1 Access to contracted water allocations

The growers initially wanted a pressurised distribution system but the costs were prohibitive (30D:182). One grower muses:

> The growers wanted the Rolls Royce version and Government said they wouldn't get a Volkswagen, but maybe a Holden. (44:16)

Two broadacre growers and one glasshouse grower would like direct feeding from the main pipe to avoid the need for huge storage facilities (45 106; 29:44; 30C:166). However, it was explained that such a system would have to be under pressure and could not supply the accumulated demand for irrigation:

> How do you make a pressurized system when Joe Bloggs is going to go and start 200 sprinklers here, and [his neighbour] thinks: 'Oh yes, he's started them, I'll start another 200 over there.' What sort of system would you have to have? … And you would need the sea as a storage pit! (44:256)

The slow flow is a problem for others. It is reported by an adviser who has contact with growers from an Asian background that although the pipe from Bolivar is big, it narrows to feed growers' dams and if too many access the water at the same time, it affects properties down the line (15:32). One asserts that the "water supply is more sustainable now … [but] the big problem is they made the pipeline to use that amount of water and that's it" (51:89,166). Growers who are located on the line that was designed to service the now defunct Seabreeze can access larger volumes. Others feeding from smaller diameter pipes struggle with the 0.54% daily rate:

> If I had it my way it would not have been accepted at that rate. They accepted that just to get it going. I went to a lot of the meetings. A lot of growers wanted more but they said: 'We have to accept this or we won't get anything; there is a chance we will lose the whole lot.' (51:192)

A broadacre grower believes the scheme should have been designed to use all of the effluent from Bolivar so that "good water" was not being wasted by being discharged into the Gulf (46:120). Other growers are concerned that the pipeline from the DAFF plant will not be large enough to supply the volume required for expansion of the pipeline (30F:228). However, the size of the scheme pipe is also linked to the DAFF plant capacity. The Bolivar WWTP manager explains that hydraulically, the plant can treat 150 ML/d, but the DAFF plant is not geared up to take this maximum loading (32:45).

WRSV explains that the flow rate enables growers to access their allocation over 185 days, spring, summer and autumn, and more than one connection is allowed per customer. So a grower with 20 ML/a can access 0.54% of that allocation per day. Two growers confirm that the contracted daily limit of 0.54% of the annual allocation to be supplied to each grower was based on the history of existing bore water use. It was believed that bigger on farm storage could be built if sufficient water could not be accessed (44:244). This daily allocation would also force people to manage the allocation that came out of Bolivar (44:239).

Generally, all of the growers understand that they are able to extract 0.54% of their total allocation on a daily basis over 185 days, although some believe the figure is 180 or 200 days. Only two of the growers have no issues with their supply at all, another two (Anglo Saxon and Cambodian) either know nothing about the daily allocation (42:145), or believe it does not exist (40:35).

Some of the growers did acknowledge that altering the volume was not possible due to the VPS being a low-pressure system (13:21; 30) and the pipes in the system have been designed to accommodate the 0.54% daily allocation. Restrictor plates had been added to make water extraction fairer for everyone along the pipeline (56:20), and by reducing the availability of the water stopped people from profiteering from their water allocations (30C:166).

Overall, of the growers who raise the volume of water supplied, 75% (18) argue for an increase in supply when they need it the most, particularly in the summer months (13; 38; 42, 35:2,21,32; 14:12, 31). Although some do not use all of their allocation, they have insufficient volumes available in the summer (38:32). To accommodate this, growers supplement reclaimed water with bore water (13:26; 35:32), and the alternative is to reduce their plantings (35:32). A broadacre grower believes the flow rate is adequate unless a period of extremely hot weather is experienced, and it depends whether or not people have bores to supplement the supply (44:205). Yet broadacre growers on bores are amongst those who need increased access to satisfy peak demands. Three growers explain that they and others over allocated, sometimes doubling the quantity, to get a reasonable flow rate for the days when they would need it (55:3,7; 35:32; 51:164). Now that the scheme has been operating for five years, a broadacre grower recommends that a review be undertaken to give people the opportunity to adjust their outlet sizing or quota needs by a certain percentage. After all, he asserts, the idea of the scheme was "not to send farmers broke" (35:27).

Five growers (perennial and broadacre) report that to overcome the restriction of the 0.54% daily allocation, more water can be extracted from the system by opening the valve on the meter or by removing the orifice plate to allow a greater flow of water. Several of these confirm that WRSV permits this practice as long as there is enough additional water in their part of the system. One clarifies that this is allowed without modification to their contracts (51:111). Another two growers further explain that this arrangement works as long as there are not too many involved as it deprives others of their daily allocation if they are further down the line (13:21; 51:65, 108). One grower admits: "We just set the flow and that is it. We don't know how much we draw each day, 24/7" (46:39).

Nearly a quarter of the growers referred to the five-year commitment for purchase of reclaimed water from WRSV. Two growers confirm that they can live with the five years' notice to terminate their water supply as they plan to stay in the area (46:57; 51:104,106). The hydroponics grower would be happy if the reclaimed water supply could be guaranteed for the next 20 to 40 years to justify capital expenditure on infrastructure, specifically expensive reverse osmosis technology (42:171). While, two broadacre growers assert that five years is a long time to determine use of water (45:170; 35:46), and so the contract seems "never ending" (35:46). They believe they were being asked to do "crystal ball gazing" in determining their water future allocation (35:14). It is claimed that the contract is not standard business practice:

> That's one thing that I would never have signed up for again, because you don't get that with anybody. I don't get 5 years' contract with … the people I supply. So, if they turn around tomorrow and say: 'I don't want your gear anymore' - and they could just turn around and do it, its not that difficult - what are you going to do with the water? ... So you know, it should be a neutral thing. At the moment it's all, its all their [way] - they've got security, not us. We haven't got security of sales, but they have. (45:170, 178)

Further, it is asserted that the growers were coerced into the contract due to restrictions placed on the bores:

> They're not real fair terms. You should get what you pay for, at the end of the day. Nobody gets - the terms that they got from growers, and we signed up because we wanted the water at the time as well. We felt pushed into a corner. So whoever goes and negotiates the next one for the next growers, that's how they pushed us into a corner. Our flow was restricted and a lot of growers needed, really desperately needed the extra water. (45:298)

4.7.2 Storage

Dams and tanks are used to store the reclaimed water, with glasshouse, perennial and broadacre growers using both types of storage. The WRSV contract stipulates that at least 24 hours storage is required (WRSV:8). However, reclaimed water storage takes on different meanings to reflect individual needs and observations.

An established broadacre grower believes "we're supposed to have three days storage" (45:116) and that it is needed because of the restriction on the flow rate from the mains. Another broadacre growers finds that storage is needed because:

> If you don't have that dam you can't use the water - you can't feed straight out of this line into your system. It's against the rules. Because it might go back into the system. (30F:215-22)

For some who use bore water and reclaimed water the storage provides the bulk of supply needed for irrigation and one grower reports that he mixes bore water with reclaimed water when he does not have enough storage capacity (45:26).

The role of water storage also has different meanings for other informants. A QA consultant suggests that storage is part of managing water quality because the growers "pump the water in; they leave it there for 24 hours, and then they use it." (52:6). An adviser understands that three days storage is required, while another has learned that storage is required because "the water allocation is spread out over a whole year, even though you might only want to use it in summer" and it is therefore stored until it is needed (21:46). This is general practice and would be the case for any source, rain or bore water (21:46).

It was confirmed by the WWTP manager that balancing storage is required at each farm because "we cannot treat that large amount of water" and "the VPS pipeline cannot get it to them. You'd be sizing the pipe for that one day a year" (32:34). The VPS has balancing storage at the DAFF plant but "that goes pretty quickly" and therefore individual storage is required to give the system breathing space to meet the peaks in demand and in the event that the water goes off line (32:34). Further information relating to the requirements of storing of reclaimed water can be found in the South Australian Reclaimed Water Guidelines (DHS and EPA 1999).

4.7.3 Transfer of water

Six growers, mostly broad acre, expressed their understanding in transferring reclaimed water, allowed under the WRSV rules. Their responses ranged from not knowing anything or misunderstanding the rules; believing the transfer of water is not allowed (34:57); understanding that transfer between properties is allowed if owned by the one contract holder, but there is a cost involved (44:217); and confirming that transfer to others is possible as long as there is enough supply in the area (45: 146,148, 151). One grower understood that written submissions should be made in order to quit the entitlement (35:46). Two glasshouse growers want to reduce their allocation but are waiting for advice from WRSV. A broadacre grower would like an amalgamated system so he can transfer water across properties in order to rest a parcel of land (30C:206). Yet, others confirm that they are already able to do this (14:14; 46:22).

4.8 Costs and pricing

Several advisers and all but three growers connected to the VPS volunteered their opinion on the price of reclaimed water or costs involved in establishing a system or in comparison to other water sources.

4.8.1 Historical factors

The potential of supplying reclaimed water suitable for unrestricted irrigation of food crops from the Bolivar WWTP was considered by SA Water for some years, but it was constrained by a lack of financial resources (5:12). As reported earlier, SA Water put the cost of the VPS – the treatment and distribution of the water - at just over $50 million, including $30 million for construction of the DAFF plant. Three growers and two horticulture advisers report that the project was kick started when the growers won the $10 million Federal grant to establish the scheme through the Better Cities initiative. Significantly, it is claimed that the BOOT operations were originally intended to be transferred back to the industry.

The fact that it was finally agreed that the scheme instead be transferred back to the government (which the growers understand as being SA Water) has implications for growers' concern for future pricing of the reclaimed water. Some recall that "the government wanted to charge much more for the water" (30:190). The water was originally priced at unrealistic rates. The government was of the opinion when we were first negotiation it, that "it should have been 90c" (41:255). "They tried to bring the water in here at 21c. and the growers just said 'No'." (41:250). Five growers articulate their concern about the future price of the water, fearing that if SA Water take control of the pipeline they "could be paying through the nose" (13:29). One grower believes that the current operators achieve a 15% return on their investment (44:283). It was made clear that there is still some interest in the WRSV operations eventually being run by the VIA.

Another aspect of costing that relates to the development of the scheme is the fact that the VPS was originally targeted for bore water users. It is asserted by growers that this was to alleviate the pressure on the T1 and T2 (tertiary aquifers). However, an adviser at the time recalls that this was mainly an economic decision – to connect the larger growers to the scheme (27:37). Either way, the connection fee to existing irrigators was less than that charged to others who had no bore water allocation:

> If you did not have bores you had to pay a different price for connection but you still had a connection. There was no favouritism to anybody. Everybody was dealt with just the same. People might think the committee were favoured. There was no favouritism. (44:394)

The pipes were distributed to service the large irrigators and therefore some people missed out on a connection to the pipeline because the concentration of growers was not near their property, or others had to pay the cost of extending the pipeline because subsidies for connections eventually ran out (44:393).

4.8.2 Contract pricing

The WRSV Amended Customer Rules, July 1997, which is still circulated to prospective customers, sets out the fees charged (as at 18th August 1997) in Schedule A, p.11. A connection fee of $1,200 is applicable to customers with a "current water recovery licence" (referring to bore water or Bolivar outfall channel water) and from $2,000 to $3,800 for others, depending upon the total volume applied for. An annual supply fee of $750 covers three connections per customer. The water use rates range from 5 c/kL in winter to 9.5 c/kL in summer with slightly higher rates charged (10.45 c/kL) for excess water and more than double the amount for unauthorised use (28.5 c/kL) if it were used in the summer peak period (p.12). Transfers or amalgamation (transferring water between one owner's properties) of water incurs a fee of $100 plus the costs involved. Other reasonable costs are made for repairs, maintenance, disconnection and termination of contract. It is also stated that price reviews occur in July of each year and increases

will be at 2.5% for the first ten years of the BOOT period and then will reflect CPI increases thereafter (p.9).

Growers generally understand the price structure, as confirmed by almost three-quarters (17) of growers connected. A quarter of these are happy with the current price of the water. It was thought by one grower that after a period of time, the inflationary factor of half, rather than the full CPI would be taken into account (13:13). Several Cambodian and Vietnamese growers were concerned that a penalty would be charged if they used more than their allocation (e.g. 46:38; 34:64).

In relation to CPI based price increase, an established broadacre grower is concerned that the price is getting too dear and if it becomes too expensive "people will revert back to their bores", decreasing their reclaimed water by a third and taking the full quota of their bore allocation (44:364). One grower explains that growers have to pay a connection fee, annual allocation fee and time based usage fee (30B:161). A glasshouse grower is also looking to the future on price:

> As long as they don't jack up the price drastically. It is a private company, but they should leave it at that – keep the same price – not like AGL. I've got a big investment in the property and so I'm depending on the fairness of the system of pricing. I know they have to make a profit, but they shouldn't get greedy. (9:37)

A number of broadacre and perennial growers confirm that they are not charged for the excess water used. They believe this is either because the water would otherwise be pumped out to sea; that the scheme is not yet to full capacity; there is sufficient water available in their section of the pipeline; or because they pay their bills promptly. Yet other growers, all from Cambodian or Vietnamese background, are concerned that they will have to pay extra if they use more than their allocation at certain times of the year (34:64; 38:36; 42:119; 46:38). One glasshouse grower would prefer a standard price range with a cheaper rate for summer (42:123, 139). For another glasshouse grower: "the company gets your money both ways in the amount you pay for and for the excess, I'm not happy about that" (40:14).

4.8.3 Cost comparisons

Several estimates are made of the cost of reclaimed water in comparison to other sources. An adviser suggests that for those on mains water, the price of reclaimed water generates savings compared to the more expensive mains water (27:22). A few glasshouse growers confirm that this is the case. However, another adviser reports that Vietnamese growers have estimated that all up, it costs around $30,000 to connect to the VPS, about the same as putting in a bore (14:22). This acts as a barrier for some. A policy maker believes it only cost up to $10,000 to put in a good production well (4.56). Bore water pumping costs are quoted at 4 c/kL to 5 c/kL for every 10 metres, at 800 kpa or 120 psi (Thomson 2000); 11 c/kL (27:23); and 2 c/kL (4:48).

A few growers believe the water is more expensive when compared with bore water (42:30; 51:142). An adviser has calculated that the costs involved are double the bore water costs (41:246). However, a glasshouse grower estimates that when the cost of the allocation, electricity and pumping costs are added up the reclaimed water is dearer than the bore water, but there are very few repairs involved. "If a pump packs up, it costs $1500 to get a new one, whereas a new bore costs $30,000" (9:11). Another grower evaluates that with bore water, "you do not pay for it but you pay for the pump" whereas with reclaimed water "you pay for the water but it is delivered to you" (56:14).

A broadacre grower believes that the cost of reclaimed water puts him at a disadvantage compared to interstate competitors:

> It's not so much the cost of the water its our main competitors cost structure is less than ours. We're doomed. So that's the big issue: cost structure based on what interstate people can land in SA. (45:251, 255)

There is some interest in converting to hydroponics and a policy maker asserts that hydroponics will achieve greater production levels per unit of labour and dollar of investment (59:24). However, the well established hydroponics grower fears that if further cuts are made to bore water allocations and he is forced to use more of his reclaimed water allocation, the cost of setting up an RO system to remove the salt will be prohibitive (42:18).

4.8.4 Take or pay

The majority of growers are concerned about paying for an allocation whether they use the water or not (34:55; 30C:232; 40:30; 51:142; 53:107; 53-G2; 38:42;40:14,30; 45:296;55:3, 34:53,55). One broadacre grower claims:

> We are paying a fair bit of money for something we are not using…we are helping the government by taking it out of the Gulf. I don't think we can hack paying this sort of amount. (55:3,11)

With some suggesting that a review could be undertaken now that the scheme has been in operation for five years. As mentioned under section 4.7.1 a broadacre grower would like a reassessment of the needs of existing irrigators to allow them the opportunity to change their allocation because, after all, the idea of the scheme was "not to send farmers broke" (35:27). Another links the take or pay conditions with the CPI increases, as reported earlier, and believes the situation needs revising because it is unsustainable and one-sided:

> I don't have a problem with the price, the price is OK provided it's just a 'user pays' scenario. And the other thing that should be looked at in that regard is, because it has a CPI increase every year, it should come to a stage where the CPI stops. I mean, I know there's added costs, but we need to get to a stage where it becomes a viable proposition all round. The plus for the government is that its getting its [effluent] out of the Gulf and I don't think anybody at any stage has been prepared to put a value cost to this, and that would be horrendous. (44:356)

A glasshouse grower suggests that although reclaimed water is cheaper, the mains system is fairer and he will look for a bore water allocation if he ever relocated due to the costs in accessing the reclaimed water (38:132,134). A quarter of the growers specifically advocate for a 'user pays' system (44:356; 62:2; 34:57; 38:42; 45:296; 53:131). One points out that the VPS is the "only system that is not 'user pays' … Why introduce this policy for your water [SA Water mains water] but not other water [reclaimed]" (44:385).

4.9 Management practices

Growers were asked to comment on their management practices in relation to water, soil, fertiliser and chemical application. Few changes were noted that specifically relate to reclaimed water. In some cases it was noted that the introduction of reclaimed water provided an opportunity for growers to improve their general farm management skills and knowledge through the increase in workshops. One adviser remarked that in the last few years he had observed a steady improvement in management practices in the region, but there was room for more improvement (50:9). Various workshops relating to management practices and sources of information have been made to growers and these are outlined in more detail in the section on Communication and Information. Specific details as to the management of reclaimed water have been discussed in the Grower Manual (Kelly et al 2001) and Hamilton et al (2005).

4.9.1 Reclaimed water and irrigation methods

A glasshouse grower reports that he filters the reclaimed water but that he also did this with bore water (9:39,41). Another fills his storage tank with reclaimed water and allows the dirt to settle out; the tank is then cleaned out annually (38:10). As previously mentioned (Nutrients), the respondent that advises on irrigation practices observes that algae can be a problem with bore and reclaimed water storage and that:

> They are learning how to treat the dams with various types of products to prevent algae from growing. (49:24)

A third of the growers have changed their irrigation practices since connecting to reclaimed water. Others make related observations. A broadacre grower explains that he did not change his irrigation practice but upgraded the irrigation system so that it was hydraulically controlled (56:9). The dripper tape used by a glasshouse grower lasts much longer with Class A reclaimed water than it did with the lower Class D:

> For the new system, I use the same T-tape for two or three years. Recycle the tape. With the old reclaimed water, the tape would last just one year. (19:2)

Glasshouse growers note other changes. One is still using drip irrigation but runs it for longer periods to leach the salts from the soil. In addition, he has changed the fertiliser application:

> I used to put the fertiliser closer to the plant but this is not good for the reclaimed water as the salt is not good for the plant. … I add calcium to negate the sodium. (29:22)

The hydroponics grower explains that his system requires water of dissolved salts under 1EC and reclaimed water is double that level, nearly 2EC (42:28). Therefore, he over irrigates "30%, up to 50% more just to flush out the salts" (42:30). A horticulture adviser points out that management strategies need to be implemented to counteract the effects of salt on their crops:

> The reclaimed water these guys are using is very brackish water, on average a lot more saltier. Along Taylor's Road the reclaimed water is not as salty as the underground water, but on average it is. So management strategies to use the water without major crops suffering losses takes a lot of work, and that hasn't been understood. (41:19)

A researcher states that the use of reclaimed water "requires only slight changes to your management of the resource" as it is similar to bore water (Stevens 2000:2).

Three growers comment on over watering. Both a glasshouse and broadacre grower claim that they do not use any more water than they have to when irrigating because it would ruin the produce (9:64; 45:340). Another glasshouse grower affirms that even though he is paying for the water and cannot use his full allocation, he would still not over-water as it may exacerbate the salinity levels (38:44). A horticulture adviser warns that although the reclaimed water is classed as unrestricted for health concerns, "as far as agronomics is concerned, it is not unrestricted - there are limitations to the amount of water that should be

used" (58a:30). The Grower Manual supports this view and relates it to the potential issues with a rising water table:

> Growers should also avoid over irrigation as this may lead to rising water tables. Water tables within around 2m of the surface are likely to lead to surface salinisation. (Kelly et al 2001:66)

Only one broadacre grower admits that he makes sure he uses all of his allocation (30F:202). An adviser believes that there has been a history of over-irrigating in the region and this is partly due to the low cost of the water in comparison to other inputs in producing a crop (21:26). Another adviser outlines problems relating to irrigation training and understanding the irrigation systems that growers install:

> All we've done in irrigation management courses is actually highlighted where all the problems are. The poor old grower goes back and says: 'I have a check list of things I'll need to fix, where do I start?' So, that's the problem, we don't have the support afterwards. … So systems aren't working well and I think that's the sort of support they need, that's the next stage for this area to be using irrigation efficiently. (41:26-7)

Blending the water

Advisers confirm that the practice of mixing or shandying different sources of water to either manage salinity levels or boost supply is a long established general practice in horticulture. Table 6 summarises the range of water sources used in conjunction with reclaimed water, and the number of growers utilising these combination. It also shows the number of growers who use reclaimed water on its own. In some instances, growers have additional properties that do not have access to reclaimed water and these are not included in this table. The total indicates the number of growers using a particular source – reclaimed water on its own or blended with other water sources. The percentage shows the total of each respective water source, bearing in mind that some growers may have multiple farming practices, that is, they may appear in the perennial and the glasshouse column.

Table 6 Class A Reclaimed water and other sources (n=24)

Categories of reclaimed water sources	No. growers/farming practice			Total	%
	Broadacre	Glasshouse	Perennial		
Reclaimed water on its own		6	5	11	41
Reclaimed and bore water	10		3	13	48
Reclaimed and rain water		2		2	7
Reclaimed, bore, mains, rain		1		1	4

At least 70% of respondents connected to the VPS have access to at least one other water source, which they use with reclaimed water. It was confirmed that many shandy their water with bore, mains or rain water (13:63; 19:42; 53-G2:33) to reduce the salt content, or mix the reclaimed water with other sources to increase the volume of water needed in the peak seasons (44:201; 45:26). To reduce the salinity, a glasshouse grower uses mains water on infant plants before introducing reclaimed water shandied with mains water (19:42). Another shandies reclaimed water with rainwater and, during winter, rainwater only is occasionally applied to flush out the salt in the soil (53-G2:33). Two well established broadacre producers use reclaimed water as their first option. Bore water is only used as a last resort for one (56:7; 45:349,351), while the other has sufficient reclaimed water and uses the groundwater now and then to keep the bore operational in case a problem arises with the reclaimed water (56:7).

Monitoring

A broadacre and glasshouse grower advise that they do not use any more water than they have to because it would ruin the produce (9:64; 45:340). A perennial grower explains:

> Growers must keep an eye on the daily flow so that they know what they are doing. Systems have situations. … Although I can't remember the actual details [of the irrigation management course] I have a good feeling of it today – it has become part of me. You can have moisture reading devices, but a lot of times you have to realise what the [plant] is telling you. (14:55)

Over-watering is avoided by a glasshouse grower even though he is paying for the water and cannot use his full allocation, because it may exacerbate the salinity levels (38:44). By contrast, a broadacre grower admits that he makes sure he uses all his allocation (30F:202). Another broadacre grower explains that although it is critical to give the crop the right amount of water he does not use monitoring devices:

> We don't actually monitor, because all the monitors that we've tested have all been crap. We just dig the soil, and its as good as any monitoring. We've starved crops of water with the monitoring [devices], they say you have to adapt it to your property, but by just looking at the water level in the soil is the best way to do it. (45:343-7)

The difficulty in achieving successful monitoring and the role of mounding to assist in identifying when to irrigate is outlined by a horticulture adviser:

> The idea of the mounding was to – if we've got a mound 20cm, say, 25cm high the idea was to irrigate until you see it wet on the outside then you could be sure that you push the last lot of irrigation to the side. …No one's going to use monitoring meters in a greenhouse. They go by when they watered last. They look at the plant; how much they put on. They're not going to take any notice of the monitoring meter. A lot of people used these gypsum block type things in greenhouses and lost crops because they failed to work. They conk out or they didn't check it right or didn't put it in properly. (50:168)

Another adviser reports that as far as he knows the growers have not changed their practices to suit the reclaimed water. He believes that over-watering may be causing contamination of the groundwater:

> Over an irrigation season most people put on much more water for the year than you actually need. So a proportion of that water goes through to drainage taking with it chemicals and nutrients to cause pollution of the aquifer. (21:26)

Testing

Several growers interviewed, mostly glasshouse producers, undertake water testing. A glasshouse grower specifically tests the reclaimed water for salt (29:24). Another claims he obtained a composition test from WRSV (42), while a perennial grower does not normally test the water but recently had the water tested at VHC (25:28). Water testing is undertaken as part of a Fresh Care course conducted through the VHC, as confirmed by another glasshouse grower. While a broadacre grower explains that he does not do "a lot of technical stuff" with the water (62:3).

The scheme operators, WRSV, confirm that they also conduct tests twice weekly to ensure they are being supplied with the water quality SA Water has undertaken to provide (2:118). United Water has a continuous monitoring system to ensure that the water delivered to WRSV meets contractual requirements.

4.9.2 Soil management

A horticulture adviser maintains that growers need support "to manage sodium chloride in the soil, which is more important in reclaimed water than bore water" (41:27). Four glasshouse growers and one perennial producer advise that since using reclaimed water they have applied calcium or gypsum to negate

the salt in the soil (29:22; 34:9; 38:108; 40:34; 51:186). One explains that he previously used plastic over the soil in the glasshouse, but it had to be removed as it allowed the salt to accumulate at the surface (29:61).

A horticultural adviser agrees that calcium can be beneficial (see also Hamilton et al 2005:197) and he explains why:

> Yes. They do have to [apply calcium] because sodium will certainly reduce calcium availability, the same as what potassium will. That's what's going on. It's just that they've got soils as hard as bricks some of them. … The wind and rain should flush that out because there's no clay load down there to stop it from going into the tertiary water. … The calcium will knock off a bit of sodium, which in turn allows the water to move through the profile a bit better. (50:49, 51, 166)

However, he warns that other essential nutrients, such as selenium, may be lacking in food grown on the NAP due to the application of gypsum for soil sodicity, salinity and poor drainage (50:177).

Four of the five growers mentioned above leach the soil. The perennial grower explains that if insufficient water is used, the salt will affect the roots (14:18). Two of the glasshouse growers mound the soil to assist in leaching the salts (38:106; 29:48). A horticulture adviser reports:

> A few of them now are going to the effort of doing these mounds and even bringing in replacement soils. … While you're irrigating you are not building up salts the way you do in a [flat] layer, you're getting better drainage and you're only having to put nutritional quantities in for that mounding. (18:247)

One adds that others leach the soil with storm water collected and stored in dams (29:48). Another advises that shade cloth is ideal to effect leaching through winter rains (8:13).

It is argued by the horticulture adviser that in the Virginia area there is not enough leaching undertaken:

> They don't put enough on, because they've got to keep the salt below the active root zone, especially in almonds and the vines. But vegetables, you don't want any salt – if it's coming out at 1200 mg/L [≈ 1880 µS/cm EC], you don't want it to accumulate at all. (50:109)

He further explains the purpose of mounding the soil:

> The idea of the mounding was to – if we've got a mound 20cm, say, 25cm high the idea was to irrigate until you see it wet on the outside then you could be sure that you push the last lot of irrigation to the side. (50:168)

Testing

Seven of the growers confirm that they do soil testing (19; 29; 35;38;45;46;53-G2). One glasshouse grower reports that he sends the soil to the fertiliser shop to get tested or goes through the VHC (29:24). Another follows the recommendations but it was suggested that it depends on the cost (53-G2). An adviser is aware of growers who have brought in consultants to test soil salinity (18:276). Another adviser confirms that growers have undergone soil management workshops through the Landcare group, did soil testing as part of that programme (50:30; 41:191). A third adviser cautions that:

> [Growers] are not going to know that sodium chloride is an issue, because they're so flat out. Yet they've seen the soil tests and they just work from one day to the next. (41:50)

4.9.3 Fertiliser management

Five growers referred to fertiliser use and reclaimed water. Two glasshouse growers have changed their fertiliser applications since using reclaimed water. One grower used to apply the fertiliser closer to the plant but due to the salt in the reclaimed water he applies it further out (29:22). He adds that in the future

he would see a need to decrease the application of chemical fertilisers and move towards organics as leaching the soil will not work in the long run (29:46).

A broadacre grower uses the same amount of fertiliser as before. He expected that the fertiliser application may have had to be reduced and was not expecting to continue at the same level (45:320). However, a glasshouse grower said he uses less fertiliser as there are more nutrients in the reclaimed water (38:22). The hydroponics grower claims that if he had to use more reclaimed water shandied with bore or rain water, he would need to use more water overall to flush out the salt and he would therefore use twice the amount of fertiliser than he does now (42:32).

One adviser claims that the "fertiliser application rate needs to consider the NPK levels in the water" (23:2). While another asserts that it is "no good doing soil nutrition unless they get the irrigation right, because the salt interferes with all the uptake of nutrients" (50:32).

4.9.4 Pesticide and fungicide management

Only one glasshouse grower referred to the use of pesticides. He believes that mains water must be used to apply the chemicals on the plants, because reclaimed water can not be used as it is not allowed on the plants leaves (34:21). A horticulture adviser confirms that he would not recommend reclaimed water for mixing with pesticides or fungicides:

> Not recommend putting this in the spray tank for mixing other stuff, unless it was maybe for nutrients but not for pesticides, fungicides and so on. … Because if you put high salt, high nutrient stuff in a tank you can end up with another chemical due to the interaction. … I think the pH isn't too bad now but that's another issue for spray tanks. (18:197-9)

The same horticulture adviser is aware of some growers who have used fluorescent dyes to investigate and improve the spray coverage of their crops, with one grower cutting his chemical use by 75% (18:310). He recommends a reduction in chemical use:

> Producing a good quality crop, at an economic price, with some certainty … and increasingly doing that with less chemicals, because the chemical situation by and large isn't that sustainable. You've got … issues, residue issues. (18:99)

4.10 Environmental impact

Various stakeholder groups gave opinions on the environmental impact of the reclaimed water. A member of the VIA evaluates the VPS as very successful for bringing people back into the district and making growers drought proof and sustainable (44:384; 27:28). An environmental policy adviser claims that the growers appreciate the benefit of the scheme but may not understand all the groundwater issues:

> They were very clear they were providing a public benefit. I think their understanding of the complex nature of the groundwater system was not that great and is still isn't that great, but, the Government supported the scheme and the Government was marketing the benefits of the scheme to the groundwater system and to the marine environment quite strongly. So they accepted what they were being told by the Government, even though they didn't have a detailed scientific understanding. (24:8)

While one wholesaler believes it is a good idea to get rid of the effluent water (7:40), another is concerned that there could be unknown environmental effects:

> It's safe for the produce, but what about the ground? If you put the water on the ground for fifty years – Bolivar water – what is happening to the land? Its like cancer – everything is in that water and it must have some effect on the ground, like a disease. … I am not sure of the quality and what it does to the land.
>
> (12:11, 29)

Another suggests that "they should use the bore water first before resorting to reclaimed water" (12:37), indicating a limited understanding of the local groundwater issues.

An environmental adviser points out the complexity of the water situation on the NAP and the interrelationships involved:

> But, our primary interest is in the reclaimed water and its impact on the soil, and of course its contribution to any perched water table that kills crops. Unfortunately for us, I guess, mixed in with that is the water that's drawn down deep from underground and the mains water and the stormwater, because you can't isolate one from the other. (17:45)

4.10.1 Aquifer depletion and recharge

A horticulture adviser explains that in the early development of the scheme some of the growers saw the reclaimed water as "an opportunity to increase or secure their production and not sustainability", while other growers were aware of the problems with the aquifer and "knew something had to be done" (27:30).

Of the growers contacted seven of them, mostly broadacre, report on the depletion and recharge of the aquifers/basin (56; 14). They claim that the reclaimed water has taken the pressure off the aquifer (14:14), and the basin is refilling in time (30C). One grower claims the gauges on their bores are indicating that the basin is rising (44:38), while another has observed that in the last four years the water levels in his bore have risen (56:2), with delight he reports:

> It used to take 30 seconds for the water to reach the surface. Now, you press the button and it is through within six seconds… Would only use half of my bore water now. It is underground where it should be … It reduces the wastewater running out to the sea; cuts down on pollution; and cuts down on costs. (56:3,16,17)

Clarification regarding the problems with the basin was explained by another broadacre grower:

> Poisoning of basin and around district. Holes in the casing - shallow water going into the deep aquifers. Therefore contamination linked with the wells. They [reports on the bores] are all being achieved, but it is a bit late she cried! Six and seven years' sufferance under this time. Bore being contaminated - knew for years. They [the Government] did not have the money to do any thing. (35:35-7)

Another broadacre grower wants to know what sustainability is so growers can manage the underground water:

> They [the government] want to change legislation to the fact that they should be reviewing underground water allocations. I don't believe they should because what they need to do is find out what the sustainability of the basin is. … We've been asking for that for the last 20 years, and we've got hairy, fairy figures all over the place, and nobody would put their name to any of that. So we've asked for somebody to do a feasibility study and tell us what is 'sustainability'. We don't care what it is, and we've got to opt to try and achieve that. … Not interested in where the water comes from, or how it gets here. What we're interested in is what 'sustainability' is. (44:35,37,58)

A glasshouse grower passionately expresses his opinion relating to the perceived water problems on the NAP:

> We are in the cone of depression… but this is all bullshit … the water table has been rising ... they don't know what they're on about … The people that read the meters said to me that they know the water table is rising and they said that in years to come he reckons they're going to have to get people to pump more water out because its rising a lot. And the other bananas are saying: 'Nah.' So you work it out! So I don't know what's going on. The water table is rising. … My personal thing [opinion] is, that the aquifers are recharging faster than what they thought they would because there's less pressure, more Bolivar water. (43:92-126)

A horticulture adviser believes that recognition hasn't been given to the growers in contributing to the recharging of the aquifers:

> What is happening is that the aquifer is starting to repressurise itself, so we're actually getting in low areas a rise in water table. So, I think, this area is conserving the underground basin and the scheme's now been here for 5 years and there's certainly been no recognition of the fact that they [the growers] are doing that.
>
> (41:12-3)

He claims that growers do not have the time to fully appreciate the situation:

> [They] understand the aquifers an issue, but it's also out of sight out of mind, if it doesn't affect me then I don't really give two hoots, and again it goes back to the fact that they are so busy. I think people have this attitude that in this area, these guys just don't care, its not a don't care factor, its actually they're just trying to bloody survive! (41:179)

There has been an overall reduction in groundwater use as the reclaimed water has been substituted for it, according to a policy adviser, but there has also been a "clear increase in production and increase in total water demand" (24:34). A brochure developed by the NABCWMB supports this claim stating that there has been a recovery of groundwater levels until the drought years of 2002-3 when the irrigation records have shown that groundwater usage increased, with the T2 aquifer dropping five metres in the centre of the cone of depression (NABCWMB 2004). One adviser remarked that some people ventured in and did more with the water than they would have, moving into more marginal areas (27:35).

4.10.2 Water tables

Whenever possible, respondents were asked whether they had experienced or heard of a problem relating to the rising water table. Generally, the growers considered the matter in relation to their own property and only a few took a broader view. Both the advisers and growers expressed uncertainty or attempted to clarify the situation.

Some of the growers believe that the perched water table comes from the Q1 aquifer. While another suggests that water travelling from the hills area may be a contributing factor. One glasshouse producer, who had been affected by the rising water, reports that the water table pushes the salt to the surface, mostly in winter, and although he can still grow, his production is reduced (29:12). Another grower claims that "if you slow down the pumping [of the bore water], the water table is rising and causing big problems … salinity and your farm would be a lake" (14:14). He gives this dire prediction:

> My land will go underground because of the rising water … It's a major issue over here. Even though we are doing something with underground drains, it's not the answer. (14:20)

An environmental regulator reports that there is an historic "seasonal shift in the water table height, which at times causes problems with crops" (17:2). A horticulture adviser agrees and believes it is difficult to directly link the water table rises to the recycled water as it was happening three to four years ago, and perhaps even in the early 1990's:

> It is seasonal so it might have been coming anyway. However, there is potential for increased surface water table rises. There are water management issues for the whole region anyway. The overuse of phosphate in soil management through fertilisation, so it is difficult to determine if it is a problem with reclaimed water. (23:2)

Another horticulture adviser reports that he has started to see localised salt in paddocks, particularly where there are depressions and it has affected crops. Although, there had been some evidence of water table problems before the reclaimed water scheme, most of it had been confined to the sea side of the region. With reclaimed water becoming available, an increase in the water table was expected but no one was sure when it would occur (27:32-4). A Department of Water Resources fact sheet states that salinisation can "occur where inappropriate irrigation or water storage developments increase infiltration of water to the water table causing it to rise" (DWR: undated b).

Marketing consultants have heard from various producers that the amount of reclaimed water being placed on crops is causing the water table to rise (22:3). One of the growers interviewed confirms this (13:31). An irrigation adviser thinks there is no question that the rise in the water table is linked to irrigation:

> When they [the growers] were mining the aquifer the fact that they were over irrigating did not cause water table rise. But, if, instead of taking water from the aquifer you put water on from another source, like reclaimed water, you both haven't got the receptacle to take the extra drainage water and you are putting more water on so you do get rising water tables and much of the area that they are irrigating with reclaimed water, as I understand it, is swamp land. So it is really not surprising that there have been areas, particularly in years that are a bit wetter than usual, where you have had watertable problems. (21:26)

A researcher agrees that the major contributor to the water table is irrigation but believes that a sustainable system can be set up on the NAP. However, he believes the 'take or pay' system is bad for the environment as it leads to people over-irrigating (58a:28). It is acknowledged that the problems with the irrigation of reclaimed water and the rising groundwater and salinity are general issues with all irrigation across Australia (1:36).

These beliefs have been reflected in a workshop on the Groundwater of the NAP conducted in November of 2002, involving representatives from State and Federal Government (DWLBC, CSIRO, PIRSA, EPA, SA Water), Universities (Flinders and Adelaide), the Catchment Board (NABCWMB), and the private sector (WRSV and private hydrology consultant). All parties agreed that:

> The unequivocal major cause of rising water tables near Virginia was excessive leaching of water beneath irrigation areas. This can be addressed by improving water use efficiency or by decreasing the proportion of area irrigated. (Stevens et al 2003:5)

The group identified several areas where information either did not exist or was "not collated in a suitable way" in order to manage the shallow water table. These included: water use patterns; leaching losses beneath crops with and without management systems; and groundwater monitoring and natural tracer

studies. The group also identified a need to "understand nutrient and salt fluxes linked with irrigation practices to determine treatment and disposal options necessary for subsurface drainage in the future" as well as an understanding of "evapotranspiration demand at different times of year" to determine water requirements and best management practices for different crops (Stevens et al 2003:5).

Drainage

Poor drainage is also considered to be one of the main causes of the rising water table. For example, a horticulture adviser's view on a 'rising water table' is as follows:

> That's only in the local area as far as I know. … That's only because there's an old floodway lagoon. They've done all the measurements and bullshit that's ever done and all it is - if you look at the old maps - its just an old lagoon going through and they took soil from the sandy rises and filled it up and they wonder why the water table comes up. (50:53)

He further expands on the relationship between the lagoon and the rising water table:

> They actually filled in a lagoon … then they planted vines on it, deep-rooted perennials. I mean what do you expect? It was actually part of a flood-way scheme that went through Virginia, which they built bridges, fiords across and all this sort of stuff. You know, good old Mother Nature is being destroyed, so the water can't get out. So that every time it rains the water table comes up. (50:55)

An established broadacre grower also raises the issue of the lagoon in response to the query on the water table. He remembers the natural drainage as Thompson's Creek and describes how it flowed all through the year until a landholder filled it in. It is his belief that "the creek used to serve a very, very serious purpose that now people are starting to realise" (44:108). It was confirmed by this grower and other informants that a pilot study, funded by the Federal Government, would explore the effect of engineered drainage to remedy the situation.

4.10.3 Monitoring

The monitoring of groundwater and surface water was mentioned by several of the stakeholder groups. An environmental policy maker claims that part of the problem of understanding the current situation is that insufficient data was collected prior to the scheme being implemented.

> One of the things that I think was poorly investigated via the implementation of the scheme was the impact on what we would call the water balance, or total water budget on the Northern Adelaide Plains. By that I mean you can consider an irrigation area as a system where water is put into it and water flows away from it. … What we're doing with irrigation is putting a lot of water onto the ground and if that exceeds the rate at which it's drawn out or used by plants, or flows through the system then you're going to get a build in storage, and that's what's occurring; that's what we're seeing occur. (24:44)

One researcher echoes this view point but believes there are now monitoring measures in place so they can observe what is happening:

> The aqua water table and other aquifers have a certain equilibrium and there is a bit of buffering capacity in that but once you exceed that you might start to get into big troubles. We didn't know enough about the lateral flow of water in the upper aquifer. So it was really important to be able to measure what was going on from all sources and whether we were going to change that a lot by using recycled water. But that information wasn't there at the time. There are things in place now to measure that now so that you can look at change and look at water table changes and water use. (1:30)

It was declared by one grower that he had tried to talk to the Government about monitoring the water table, but that it "fell on deaf ears" (44:69, 71). In frustration he muses:

> That's my biggest dilemma with them – all they want to do is introduce legislation to make life miserable. I'm sure they sit there and think: How can we stop those guys up there today. (44:71)

An adviser explains the network of groundwater monitoring wells that have been installed across the NAP:

> DWLBC have a network of observation wells, the ObsWell network. The water level and in some cases the salinity are measured on quite a regular basis and that data gives a pretty good picture as to what has happened over time. I know that since the appearance of the rising water table, additional ObsWells have been put in and water level loggers have been put on those ObsWells, so there should be a pretty good data set. …When I had a look at that data it was pretty clear that when an irrigation had gone on the water table had risen. (21:28)

It is understood that the ObsWell network has been operating for several years. The data is stored "in the State Government's SA Geodata database and records are accessible through the ObsWell facility over the internet" (DWR: undated a). It is confirmed that an additional 56 wells have been put in place since 2003 and the data is currently being analysed with a report due to be released early 2005 (17:6-7).

An environmental policy adviser explains that it is typical of irrigation systems to monitor where water is extracted from, to establish the reliability of the source rather than what is happening at the surface. As a result, he claims that there has been no monitoring carried out on the surface water table on the NAP (24:70). To rectify this, the VHC and NABCWMB have recently obtained funding of approximately $300,000 from the National Action Plan for Salinity and Water Quality to establish a shallow water table monitoring network and to pilot a sub-surface drainage scheme to determine how efficiently water can be extracted from the surface (24:70).

The Groundwater on the NAP workshop, referred to above, acknowledged that hydrological data is now available but there are no resources to interpret them. Therefore, a rough estimate was made of the contribution of inflows to the water table on the NAP, which has shown that irrigation makes a 60% contribution to the water table (see Table 7 below).

Table 7 Estimated contribution of inflows to water table taking into account runoff from intense rainfall events

Source	Amount (ML/a)	Amount (ML/a)	% Contribution
Excess Irrigation (leached)	8831		
Appropriate leaching fraction	2154		
Net irrigation contribution to water table		10 985	60.0
Rainfall (includes intense runoff calc)		3 675	20.0
Mains Water Domestic		2 000	11.0
Glasshouses		785	4.3
Virginia, MP and AV Storm Water		559	3.0
Water Dumping		170	0.9
Q1 Aquifer Leakage		124	0.7
Wetlands		87	0.5
Irrigation Dams		26	0.1

Source: Stevens et al 2003:9

The investigation concludes that, historically, the NAP is an area of shallow water tables and is therefore at risk when irrigated.

> Expansion of the irrigation in the region will result in shallower water tables unless water use efficiency increases. … Improving water use efficiency is much cheaper than installing groundwater drainage systems. (Stevens et al 2003:16)

It is recommended that a Land and Water Management Plan be implemented (Stevens et al 2003:16).

4.10.4 Water and Irrigation Management Plans

An Irrigation Management Plan (IMP) is part of the licensing requirements of the scheme (see South Australian Reclaimed Water Guidelines 1999:33). It is claimed a Water Quality Management Committee meets every year and one of its functions is to approve and accept the IMP monitoring report. An environment manager confirms that:

> Since the irrigation started out there, we had an Irrigation Management Plan developed initially through SA Water's licence through the Bolivar Wastewater Treatment Plant, and that irrigation management plan tried to draw in all the different players - PIRSA, DWLBC, SA Water, the Catchment Board, WRSV, EPA - and tried to set up responsibilities for each of those players for doing various monitoring parts that were required. (17:3)

The WRSV manager confirms what the IMP entails:

> Every year we have test bores throughout the area and they're measuring for levels and also quality of water annually. And again, all this information is audited by [independent expert]. That's a compiled report. (2:166)

Some horticulture advisers, an environmental regulator, and the reclaimed water provider believe that a holistic view is required to gain a complete picture of the effect of irrigation, rather than the narrow focus on reclaimed water. It is well documented that irrigation efficiency and property management practices are important to reduce the potential for water logging or salinisation of irrigated land (NABCWMB 2001 a:37). In relation to monitoring the IMP for the VPS, an environmental adviser claims that it needs to be undertaken by the various organisations such as PIRSA, DWLBC, SA Water, the Catchment Board, WRSV, and EPA to confirm the different responsibilities for each organization (17:121). He observes:

> In reality, what happened was that it probably wasn't well enough defined about who was doing what and when they were doing it. And so, a lot of what should have been done in terms of monitoring wasn't done. (17:3)

A horticulture adviser recalls that there were a lot of contributors in monitoring the environmental effects but it was not well organised or well resourced (58a:17). He recommends that in setting up a new system it would be preferable to ensure that the expertise and coordination is firmly in place (58:11). Workshop participants that studied groundwater on the NAP support this by saying that "researchers must collaborate in order to take management of issue to growers" (Stevens et al 2003:7).

An environmental manager believes that water monitoring is the only way to ensure responsible irrigation management (17:61). A policy adviser explains that it is difficult to determine how good the growers irrigation efficiency is if there has not been enough monitoring. However, he points out: "If every other irrigation area around Australia can improve their efficiency then you would guess the Northern Adelaide Plains is no different" (24:60). The environmental manager would like to see a risk based approach taken to irrigation in the area. He explained that by this he means:

> Having really good monitoring at a farm level on irrigation event frequency – or just irrigation management issues like irrigation depth, irrigation event frequency and distribution uniformity – they're the three critical things when you irrigate. So that means having soil moisture monitoring equipment on site and you'd want to be using the best technology you could get your hands on at reasonable cost. You know, like soil moisture probes, computer based monitoring, that automatically schedules your water. (17:10, 61)

It is his understanding that a limited number of growers are monitoring at this level, and suggests that a more practical, interim solution might be more suitable:

> Perhaps the early warning or the floating flag system that operates in the Riverland could be installed adjacent to growers' properties all over the region. Because they are quite economical to install. (17:123)

This system - the Full Stop wetting front detector developed by the CSIRO - has also been successfully used in the Clare Valley and Angus-Bremer regions, to improve irrigation efficiency and preserve groundwater (Thomson and Poppleton 2005; Thomson 2004). A grower-based irrigation annual reporting framework, which is a "self-education by irrigators" was also utilised in conjunction with the Full Stop system.

4.11 Related issues

The matters outlined in this section were raised or considered in response to other questions in a way that suggests that they have some impact on the long-term sustainability of horticulture, either in the NAP or generally.

4.11.1 The market

It was reported that a VHC recently appointed a market and export adviser and two marketing consultants interviewed have run a course through the VHC. Several respondents representing different groups raised the issue of a 'glut of produce' on the market and some pointed to the need for effective support to develop export markets. An established carrot grower explains that he has enough produce to export to SE Asia but because China is now exporting to that region, he concentrates on the domestic market, which is very competitive:

> We have all extended our production. The carrot tonnage has trebled. Shocking carrot market! (35:40)

A QA adviser confirms the severity of the problem:

> When there's a glut like that it hurts, but this is the third time, and I've actually been talking to [name concealed] about it. He says: 'Yes, every time this has happened its gotten worse.' So he's sort of dreading the fourth time. And what do you do when you're one of the major suppliers out of South Australia?
>
> (52:155)

A policy maker confirms that there is a "clear increase inc production" (24:34). Taylor et al (1995) alluded to this problem in his report on the Horticultural Development of the Northern Adelaide Plains by stating that due to the static nature of the domestic market "the additional production envisaged will have a downward effect on prices unless additional markets are found" in export (p. xiii). An adviser explains that the industry tried to obtain figures on the level of production in the area prior to the VPS going on line. "However, the growers thought that if you tell the government how much you produce, you tell the tax man" (27:59).

Potato growers are affected. One grower who did not have time to be interviewed advised that the only problem with the introduction of reclaimed water is that there is now too much produce grown. An established grower concurs: "Guys growing spuds are lucky to break even" (44a:27). However, another broadacre grower believes it has nothing to do with reclaimed water, but there is overproduction in the glasshouse sector because " it is pretty easy to produce and they don't have the enormous capital outlay" (35:39).

A wholesaler believes that if production is expanded further with the VPS Angle Vale extension that "new farmers – the backyarders – would be attracted to it and this stuffs up the market"; he predicts they will all connect because reclaimed water is cheap compared to mains water (7:33). The introduction of reclaimed water in Werribee Victoria was raised by two wholesalers. One believes it will cause more production, which will lower prices even further: "Reclaimed water will make our profits worse. We can't grow to what the prices are now" (8:53). He advises that there is already "a glut on the market" so unless the expansion of reclaimed water "is backed up with export" it will create real difficulties (8:55). Another wholesaler explains why over-production may occur, giving the example of growers in Werribee. It won't be due to an influx of new growers to the area, but because existing growers will have to pay for reclaimed water and more water will be available. So these established growers will plant more: "they will overlap the products and then there will be too much product" (33:36). Additionally, they won't be able to sell it in their home state, so they will be exporting it interstate which will further erode their profit margin due to packaging and freight costs. "Some growers will shut up shop and some will collapse" (33:37).

A grower confirms that production of his product line will increase because "we are price takers" (13:4). All operating costs are fixed by others and the only variable which growers have some control over is the output that can be achieved from the overheads. More water means the ability to produce more (13:4). However, he adds that "gluts have been with us for years" so it has nothing to do with reclaimed water (13:57). A wholesaler believes in the mechanisms of the market:

> It should be OK. This is market. It is free trade. Can't stop people. Free country. More in the market – it is better for the customer, the public. More means better price. More competition. (34:48)

Yet, the market hurts.

In relation to exports, two wholesalers claim that the industry needs support to ship produce and establish an overseas market. One has put a lot of effort into building exports but could not compete with US subsidies:

> The US was killing me. It is a freight issue. I was airfreighting to Singapore and the US was sending lettuce by sea in a giant cool room – subsidised - so that it was a lot less than I could airfreight it. If we had a subsidy from the government – we would need a ship – we would need government support to compete in that market. A joint venture with the government might make it work. But with export, it's 'go out and do it yourself'. (33:45)

Three other respondents admire the efforts of one Virginia grower and it was confirmed by different sources that he has struggled to establish an export market because no government assistance was forthcoming.

4.11.2 QA and packaging

It was established with each grower connected whether or not they had a QA system in place. Almost three quarters have a system, as shown in Table 8. Two glasshouse producers report that they invested time and money in the stringent SQF 2000 system because they were advised this would qualify them to supply the big chains, Woolworths and Coles. However, the supermarkets categorise their operations as being too small and, as one expresses: "they won't talk with me" (53-G1:281).

Table 8 QA systems of growers connected to the VPS (n=24)

QA system	Farm practice	No. growers
None	broadacre (2), glasshouse (2), perennial (2), perennial-glasshouse (1)	7
FreshCare	broadacre (2), glasshouse (2), perennial-glasshouse(1)	5
HACCP	broadacre (2), perennial (1)	3
SQF 2000	broadacre (4), glasshouse (3), perennial	8
WQA	perennial-glasshouse (1)	1

Two growers do not trust packing sheds in terms of how they sort the produce (19:22; 56:47). One of these is a broadacre grower who cannot see the need to adopt a QA program. He has invited a QA system manager to inspect his property to demonstrate the level of quality he maintains but as yet this has not happened. Another grower's opinion resonates with this claim. In relation to QA, he says it is no challenge because:

> We have been doing it from day dot. Now they just want it written on paper. They specify everything now. Just another thing we need to do, but we're already doing it. (8:37)

By contrast, another wholesaler/grower embraces the SQF 2000 system and has his own cool room and packing shed. Another three glasshouse growers interviewed also pack their own produce. One reports that the "standard of packaging in Adelaide is hopeless. I've designed my own box" (9:55). He believes that other growers are not following withholding period guidelines:

> I don't want my kids eating [produce that has just been sprayed with chemicals]. It is important to follow that regime. That's why you need market gardeners with a bit of background knowledge. If there's a withholding period [it should be respected not driven by] greed. Everyone should abide by the rules. Some don't adhere to withholding period so as to meet daily market prices. (9:47)

Market-driven picking is also a concern for this wholesaler in relation to the appearance of Virginia produce:

> The produce itself – how it is presented. Not because of the reclaimed water. It is not picked at the right time. They're chasing price and so picking it too small. (10:15)

Yet, a QA auditor volunteered information that relates to picking crops during withholding periods, as follows:

> The one thing that I will say about the majority of growers out at Virginia they've got good spray diaries. And they are actually critical to making the whole thing work. (52:60)

Comments made by wholesalers suggest that presentation of some local produce is not up to standard. One believes produce from Melbourne and other states is presented better (7:43). And another elaborates:

> Packaging is a major concern and that probably will be a major concern because in years to come the QA endorsements will come into place. Some growers can afford the changes required to meet the conditions, and others cannot afford it. There's an audit every six months and twelve months. It is going to take a bit of adjustment. Asian growers are not putting in the right standards. Not just Asians, but first-time growers. Other professional growers put a lot of money back into their business. If you are competing with others, you have to get at a good level if you want to be a grower. If not, there is no point in coming to the market – the produce won't be sold. It won't be saleable. It's important to have good packaging - what the product looks like. It needs to be quality. (33:10)

4.11.3 Hydroponics

Hydroponics technology is being promoted as the way of the future by some policy makers to overcome soil diseases, and to increase production levels. The higher technology will need to be accompanied with a "higher level of management and people management skills" (59:21).

As earlier reported, the hydroponics grower who currently uses part of his reclaimed water allocation as a back-up source, believes that the cost of relying on reclaimed water as the main water source will be a costly venture because it will involve RO capital expenditure (42:167). Another reports that "people don't want to invest a lot of money" in hydroponics (38:102).

4.11.4 Labour

Most respondents acknowledge that labour is one of the challenges facing the industry. Several, including a wholesaler/grower report that good labour is hard to find:

> The labour force on the farms is not great. It is very hard to get people to do what you want them to do. I could grow 200 acres, but I only grew 20 acres this year. The labour is not willing to work. They're not good workers. I've tried them a few times. (8:33)

Many glasshouse growers operate as family businesses, relying on their wives, children or other relatives for help during planting or harvesting. Where hired help is acquired, an adviser claims it is the most significant cost in production (58:26). A large washing and packing business reports that one of the logistical reasons for basing their operations in the region is because of the good labour pool accessible in nearby suburbs such as Elizabeth (54:9). He stresses that the horticulture industry understands the critical importance of labour:

> We found out three things that we believe is [the] key. One is access to water; two is access to labour; and three is access to education. A lot of the farms think that because it's a farming job you don't need much in the way of intelligence, you know. And you throw them onto the three-quarter million dollar tractor with no training; and they drive half a million dollar trucks; you spray chemicals on a million dollars' worth of potatoes. There's a lot of education [involved]! (54:32)

4.11.5 Future Of the NAP

Expansion of the pipeline

Negotiations to expand the VPS by 20km to the Angle Vale region (EarthTech 2005) north of Virginia are underway. It is believed by one grower that SA Water is contributing $1.7 million to the pipeline extension (44:285). However, WRSV have not yet finalised their commitment and the South Australian Treasury may be taking up the shortfall (44:285). WRSV advise that, potentially, another 3 GL will be taken up in the Angle Vale extension and this will bring the scheme up to the 19 GL/a capacity (2:44). Yet some growers and advisers are not convinced that it will go ahead. Some of the existing reclaimed water users are concerned that it may affect their existing markets.

As reported earlier, a wholesaler claims that "backyarders" will connect because the water will be cheap compared to mains water (7:33). A grower speculates that the extension may cause the operators to consider reducing the 0.54% daily allocation so they can "sell more on elsewhere" (44:28). Two growers claim that the pipeline is not big enough to support the volumes required, with one claiming that the line shudders already during peak flows and others reporting a decreasing or lack of flow in certain sections of the pipeline when growers take in excess of their allocation (30F:228; 51:112; 13:23).

The Northern Adelaide and Barossa Catchment Water Management Plan 2001-2006 recommends that:

> Environmental studies investigating the long term effect of effluent use on land and water resources should be a priority before committing to infrastructure and development based on this source.
>
> (NABCWMB 2001c:9)

The plan goes on to say:

> The potential exists to import effluent from the Northern Adelaide Plains via an extension to the Virginia Pipeline Scheme. Further investigation is required to demonstrate the economic viability of such a proposal and to ensure that unacceptable impacts upon other users and the environment are avoided.
>
> (NABCWMB 2001c:9)

The currently released Water Proofing Adelaide (2005:6) report, states that it will be promoting the use of wastewater, "particularly for agricultural and irrigation purposes" in order to allow growth in agriculture, protect the groundwater sources and the marine environment. The proposed strategies for 2005 to 2025 in the report include:

> A new groundwater management regime in the NAP prescribed wells area will reduce extractions to sustainable levels, maintaining the resource for future generations.
>
> Opportunities will be explored to substitute treated wastewater for groundwater use in some parts of the NAP.

> The SA Government will explore ways of better managing groundwater resources in the Adelaide urban area to prevent them from being over exploited. (Water Proofing Adelaide 2005:23)

It is also noted that in addition to the Angle Vale extension, the Mawson Lakes development that features 'third pipe' infrastructure will also be going 'on line' early this year. This scheme will take reclaimed water from the DAFF plant shandied with stormwater to reduce the levels of salinity of the water so that it will be suitable for municipal and household garden irrigation, and toilet flushing. The volume demand is estimated to be 400 ML/a with a peak summer flow of around 2.5 ML/d (66:21).

Aquifer Storage and Recovery (ASR)

The possibility of using ASR for off-season storage of reclaimed water was aired with growers when the VPS was being developed. Many growers resisted the ASR scheme "believing that it may degrade the groundwater supply" (Taylor et al 1995:16). An adviser confirms: "people weren't sure of the implications to the aquifer" (27:25).

Since then, ASR technology has been further developed through a CSIRO and United Water International Pty Ltd project, and this has received international recognition. It is reported:

> The large-scale implementation of such a scheme would overcome the expense of surface storage, and prevent large-scale evaporation and seepage losses. A successful trial could lead to over-winter storage of nine billion litres of recycled water for summer reuse. (DWLBC: undated a)

One grower who responds on the idea of ASR is interested, but is concerned about the risk:

> As long as it doesn't mess with what our existing aquifers are, and as long as they don't do any environmental damage down there - do something that we're not going to be able to fix up - then they can go ahead and do it. But, we've got good groundwater and I don't really want to risk that. (45:124)

In the area of future policy, other informants advise that if ASR is viable, it could provide balancing storage to allow the DAFF plant to operate at a steady rate 365 days a year (32); it will be a solution to curbing discharges to the Gulf (59:43) and relieving some of the pressure on the T1 and T2 (5:62).

General reflections

A few respondents raised the possibility that the NAP will evolve from horticulture production to providing housing. For example: "I don't see this area being horticulture for the next 50 years" (41:126). At this stage, SA planning authorities advise that the area is zoned for Rural Living (2), Rural Living (Animal Husbandry) and that Horticulture Zoned Land Division is limited by specific policies and is discouraged (5 August 2004).

As mentioned above one grower believes the rising water table will swamp some areas (14:20) and another believes that outside competition will overcome the local market:

> I don't think there is a future for anything in the area. Bigger companies, competition in the Riverland. It will be too expensive to grow here in the long run. (51:127)

Glasshouse growers find it difficult; two are looking forward to retirement. Another reflects: "The hardship is growing. I would be happy to walk away - battling and battling for what?" (43:259). Escaping the mundane routine involved in mono crop production is also expressed:

> I grow just the same boring things everyone around here grows. It is getting worse. It is no life here. It is hell! … The growers were making money until about ten years ago – just before I started to grow! (37:27,31)

Other growers seem more optimistic about their future as long as prices for inputs stabilise and returns increase. Advisers believe there is a good future on the NAP but explain that this will depend on sustainable, management practices. Advisers, researchers and one policy maker believe sustainability can be achieved through collaborative effort and another policy maker is enthusiastic about modernisation, particularly hydroponics.

5 Discussion

The range of data presented in this report illustrates the complexity of social and environmental issues working through the process of introducing Class A reclaimed water for the irrigation of food crops on the NAP. There is evidence to suggest that the VPS has been successfully implemented and is socially accepted; yet there are issues and concerns that are in part being addressed, or will need acknowledgement and attention, in order to achieve long term sustainability. If the goal is to achieve sustainable irrigation using Class A reclaimed water, then the navigation of these data through the five step trust building model outlined in the literature review assists in clarifying influencing factors. In the light of these data, the model can now be depicted as shown in Figure 4 to underline the ongoing process of 'active trust' (Giddens 1994) that requires negotiation and reinforcement through both 'top down' and 'bottom up' influences.

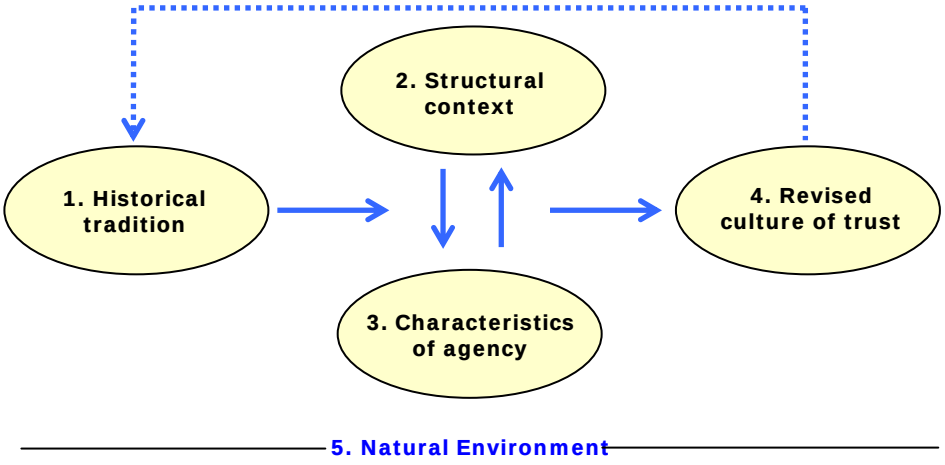

Figure 4 Trust as an ongoing process (based on Sztompka 1999)

Beginning with the historical tradition of trust (1) in reclaimed water, it is confirmed that some growers in the Virginia area have prior experience of using Class D water commonly referred to as 'channel water', sourced from the Bolivar WWTP. Although there was a measure of dissatisfaction expressed, due to problems with tests and restrictions on irrigation that relate to the quality of the effluent water, it was used for some decades. It was this experience that caused some growers to lobby for a higher quality source, which established a level of trust in reclaimed water and provided the context in which the VPS was negotiated and finally implemented. The structural context (2) and characteristics of agency (3) were, therefore, positively influenced by the historical tradition of trust in reclaimed water and the growers' desire to have access to a higher quality water for unrestricted irrigation.

Consideration of an upgraded delivery of reclaimed water occurred at a time when SA Water was under pressure from the newly formed EPA to curb discharges to the Gulf of St Vincent.(5) Additionally, depleting groundwater resources and aquifer contamination, resulted in bore water allocations being capped. Growers experienced hardship in drawing out their permitted allocations, managing increased levels of salinity, and coping with the limitation to expand production. At the same time, the Department of Health took an active interest in gathering and further developing the evidence-based knowledge required to ensure the reclaimed water met Class A standards as later outlined in the South Australian Reclaimed Water Guidelines (1999). Funding bodies such as SA Water eventually invested in the DAFF plant, the pipeline and outsourced the management of the VPS to WRSV under the BOOT scheme. Therefore, as the SA Water informant suggests, the VPS came together through "a happy coincidence" (5.6) of various push and pull factors. Other structural supports available through CSIRO researchers and

PIRSA activities that offered information and advice were implemented early in the schemes establishment.

Actual acceptance of the concept of using reclaimed water for irrigation, by growers (3) not directly involved in lobbying for the scheme, was problematic. Applying Renn's (1990) theory, those on the periphery of experience (for example, those with no 'channel' water experience) or who were not closely connected to growers with an overall positive reclaimed water experience (Canter et al 1992), will be more likely to react negatively to agricultural reuse that those 'innoculated' against the concept (Renn 1990:156). This appears to partly account for the negative responses recalled by growers who are connected to the scheme. Another factor that comes into play is the historical culture of distrust (1) present in the community towards government proclamations and initiatives as outlined under Section 4.4.5 Impediments to take up of information. In this situation, a well constructed public consultation process would be beneficial.(2) From the data, there were several meetings held over time and initial anxieties eventually dissipated. The problem then moved from public health concerns to farm management issues relating to volumes, quality and price, with two proposals being put forward before the conditions were finally accepted, albeit with some reluctance as reported by some of the growers and advisers.

The cultural diversity on the NAP has also influenced the take-up of the scheme.(3) There are several respondents who claim that information on the VPS (2) was made available to Vietnamese in their own language. A PIRSA (and later Rural Solutions SA) interpreter was present at meetings early on in the schemes establishment and workshops that were held to support the information presented in the Grower Manual. It was reported that the WRSV contract is not issued in other languages and although the Grower Manual was summarised in the Vietnamese language it was distributed only to WRSV contract holders. Therefore, if the estimates of the number of Vietnamese growers are taken into account, it would seem there are large numbers of growers who were not made familiar with the VPS details. A local Vietnamese trader confirms the difficulties involved in overcoming the cultural divide, not only for growers with an Asian background but also for immigrants of other nationalities. Despite the fact that he can speak English, he is 'too afraid' (or perhaps embarrassed) to make enquiries at the WRSV office in order to gather information on the scheme to have translated and published in his quarterly newsletter. Therefore, information on the VPS is not being circulated or understood as well as it needs to be in order to reach existing and new entrants to the scheme. In addition, although growers may be able to speak and understand English they may not be literate in the English language, and as one grower pointed out it takes time to interpret the information presented.

At the same time, as mentioned above, the VPS was originally intended to alleviate pressure on the T1 and T2 aquifers and therefore targeted existing bore water users. After all, a group of keen broad acre and perennial growers who relied on bore water were amongst those who were actively involved in the successful implementation of the scheme.(3) From the accounts given, it is suggested that some individuals were even prepared to over-allocate the amount they needed in order to get the scheme 'over the line' when the 4 GL/a Seabreeze requirement fell through, and they encouraged others to do the same. Compared to this level of commitment, the glasshouse growers (3) might be seen as fortunate adjuncts to the scheme. They typically require less than 25 ML/a and one of those interviewed had a bore water licence. However, unless major bore water users are added to the scheme, the smaller concerns will be needed. Further, it is mainly the glasshouse growers that take the water in the winter months, helping to spread some level of demand throughout the year.

The literature on acceptance of risk and adoption of new technology relates to the uptake of reclaimed water for horticulture and can be compared to the findings of these data. Access to the reclaimed water and therefore the availability of the technology (Wilkie 1986) to treat and deliver the water is confirmed as an obvious, necessary, but not sufficient reason. Advisers claim that although some growers had an understanding of the environmental issues, concern for the environment was not a key driver for them to

connect to the scheme. Many connected to the scheme to gain access to water as a security measure in the event that bore water allocations were cut further. Therefore the 'obtrusive nature of the environment' (Gooch 1996) was also realised making bore water less accessible.(5) Others wanted to resource the expansion of their business. Water quality (Casey 1997) was another influence that was developed to meet growers' demand for a source that could be used without restriction, compared to the 'channel' water, or bore water that was too salty. It was also to stave off criticism at the market place, correlating with Canter et al's (1992) normative influences (3) that determine acceptable levels of water quality risk. The economics involved that promised cost savings for mains water dependent irrigators was also a factor.

It is argued that the growers were also encouraged by the process of information gathering and dissemination of evidence on the safety of Class A reclaimed water, undertaken by the CSIRO, the Department of Health, SA Water, PIRSA, the Playford City Council, VHC and the EPA who also contributed to the crisis management strategy following implementation.(2) At the same time, this generated and built trust in produce irrigated with reclaimed water in the market via retailers, wholesalers and QA advisers. Therefore, trust in the institutions that support the new technology (Short 1984) is suggested. Conversely a lack of institutional trust (1) explains the decision not to connect for those concerned about water quality. More time and effort required in the adoption process against limited advantages (Nowak & Korsching 1979) caused at least one busy grower to delay connection. The lack of control (Casey 1997) was a problem for some in relation to the 'take or pay' contractual requirement and it is reported that some growers saw the effluent as being imposed on them, suggesting the idea of protecting one's territory from outsiders (Gooch 1996) and an involuntary situation (Fischhoff et al 1978) that is not conducive to risk taking. The lack of access to information (Audirac & Beaulieu 1986) may explain the low rate of connection amongst growers from a non English-speaking background, if the estimates of the number of growers from an Asian background are accurate.

When the current data is compared to the previous social research (section 4.2), it is observed that growers confirm the benefits of reclaimed water as being increased production and the ability to grow other crops. However, there are concerns relating to over-production as indicated in Bewsell and Kaine's (2001) national study and flagged prior to the scheme going ahead (Taylor et al 1995). The reductions in fertiliser did not come about probably because of the denitrification process later introduced to the treatment train of the effluent at Bolivar WWTP. Growers are still concerned about soil salinity, soil sodicity, the rising water table and they are no longer as worried about soil biology, heavy metals, produce quality, bacteria and market in terms of the acceptability of produce irrigated with reclaimed water. Although it has been noted that growers were concerned about microbial contamination of their produce from algal growth in their storage facilities (Kelly & Stevens 2001), this did not arise as an issue with growers interviewed in this research. Finally, contrary to the previous research finding that growers are concerned about public perceptions, Virginia respondents may have initially been worried, but they are not concerned today.(4)

Concerns related to the public health effects of using reclaimed water have generally been laid to rest. Both growers, wholesalers, researchers and QA advisers confirm that there is no detectable difference between produce grown with reclaimed water compared to food irrigated with other sources of water. QA advisers explain that all produce, particularly that grown by new entrants into the market, is put through the same process of testing and crops and packing sheds are inspected at least once annually.(2) In addition, the large supermarkets put the food through their own rigorous quality assurance evaluation so that very little is left to chance. These rigorous practices feed back to retailers, wholesalers and growers (3) to give assurance and maintain or increase confidence in reclaimed water for horticulture irrigation. However, some respondents engaged in deeper reflections on future, yet unseen outcomes, such as heavy metals. The literature confirms that risks that cannot be detected or are yet unknown are less acceptable than those that are visible (Fischhoff et al 1978) and therefore more easily assessed. It was noted that the

wholesalers and QA advisers do not have updated information such as the Grower Manual to inform them of preferred grower management practices and the latest developments in reclaimed water.

It has been observed that there were few changes in management practices that relate directly to reclaimed water. Other changes have occurred and these may be due to the increase in workshop activity as a result of the implementation of the VPS.(2) Therefore, the scheme provided an increased opportunity for learning to improve farm management practices. Significantly, the workshops were conducted by different providers, such as PIRSA, Rural Solution SA, SARDI, the Landcare group, as well as the VHC and were either held on the premises of VHC or in the field. However, there has been a reduction in workshops in recent years, which may have disadvantaged new entrants to the industry and not provided opportunities for growers to refresh their knowledge and skills. It was also confirmed by growers and advisers that follow-up processes, to determine whether the practices have been implemented, is not standard procedure, so it is difficult to determine the impact of the training. The last workshops relating specifically to reclaimed water were conducted late 2001, early 2002. Perhaps as a consequence, it was observed that water testing or monitoring does not occur to any great extent and soil testing is more common than water testing.

Salinity is an ongoing problem in the region and is a difficult issue to address, as there are several potential sources of salt intrusion. These include the rising water table, use of bore water which in some cases is equivalent to or saltier than the reclaimed water, questionable fertiliser and soil ameliorant use, and efficiencies relating to the volume of water applied. Almost half of the growers interviewed that are connected to the scheme are using reclaimed water on its own. It is maintained by advisers that, if salinity is managed by gypsum alone, this may cause deficiencies in other essential nutrients. Further, there is no clear understanding of what is happening with the hydrology of the region.(5) It is acknowledged that there are seasonal shifts in the surface water table by some of the stakeholders, but there is a stronger argument made by others that the increase in the water table is due to irrigation. There is also a case made by growers and advisers that there are impediments to natural drainage in the region.

The NABCWMB reports that, generally, since the implementation of the scheme there has been a reduction in groundwater use but an increase in total water demand. Growers have observed that their bores are showing signs of being replenished. The data on management practices and on the environment highlight the lack of coordination of research and monitoring prior to and following the implementation of the VPS.(2) The initial momentum of collaborative effort that worked for the crisis management group, to address rumours and claims against the water, did not evolve into an ongoing commitment to research and communication between responsible, supporting institutions and the growers. At this stage, there is no clear proof to support the proposition that the introduction of reclaimed water has caused the rising of the shallow water table. There is data available but not the resources for collation and sharing of the findings. However, one estimate suggests that irrigation makes a 60% contribution to the water table (Stevens et al 2003) and therefore it may be deduced that because there has been an increase in the area under production, that some or most of this can be attributed to the use of reclaimed water for irrigation.

There is an IMP in place, as part of the licensing requirement for the VPS, and it is reported that monitoring occurs as part of the plan and that it is approved and accepted annually by a Water Quality Management Committee.(2) However, the WRSV manager, the EPA, the NABCWMB, advisers and some growers agree that a more holistic approach is required to gain a better understanding of the affects of irrigation rather than the narrow focus on reclaimed water. As one grower asks: “What is sustainability?” (44:37). Others also comment that they need a definitive answer, however, science is inherently falsifiable and therefore ‘scientists do not agree’ (Douglas & Wildavsky 1982). If government and other interested agencies could develop a more coordinated effort in conjunction with the growers, this would help reach consensus on what is admissible evidence to define the problem. It would appear that they are partly there with the monitoring mechanisms currently in place (awaiting final report) and the proposed

surface water monitoring and drainage project. The next step will be to garner sufficient resources to share information with growers and, if necessary, to develop on-farm management strategies to monitor the situation.

In other regions (Angus Bremer and Clare Valley), the practical Full Stop wetting front detector developed by the CSIRO has been successfully used, supported by a grower based irrigation annual reporting framework (Thomson 2004; Thomson & Poppleton 2005). This assists in irrigation efficiency and the preservation of groundwater resources with the added benefit of managing salinity. Virginia growers identify salinity as a problem, either relating it to the reclaimed water, salty bore water or soil salinity. An environmental adviser recognises the value of such programs and reports that the "[Full Stop] floating flag system" is also working well in the Riverland (17:123). It is argued that the grower driven annual reporting framework implemented in Angus Bremer and Clare Valley could be adopted by the growers in Virginia in conjunction with supporting agencies.(2) Thomson (2004) asserts that "government-owned-and-monitored network of wells" may produce "unpalatable data" to growers alienating them so they are less likely to accept the results and make the necessary changes. This could exacerbate the problem, putting the environment at more risk.(5)

In relation to contractual arrangements, some growers voice concerns relating to the 'take or pay' arrangements, the restrictions on daily access of water, the five-year term commitment, and the price of the water. These concerns symbolise their perception of a lack of structural support (2) for their business entities, which may work to decrease their confidence (4) in the VPS. Of the 24 growers interviewed who are connected to the scheme, 18 would like access to more water during the summer growing season than their contract allows. They argue that the 0.54% daily limit is too restrictive. However, this is the level negotiated with growers to enable implementation of the scheme. At this level, the pipeline can accommodate the total accumulated demand of all water users when the scheme is at full capacity. The price of the water is not so much a problem, except for concerns about future increases. Also, it is strongly asserted by the growers that the pricing structure should be based on the 'user pays' philosophy, which is applicable to mains water charges and electricity. The main concern is that people are paying for water they cannot use, and are tied to this commitment for the five-year minimal period, unless a transfer can be made to another grower. A horticulture researcher suggests that the 'take or pay' scheme may encourage over-irrigation practices.

There is another significant group of growers, and these are the 'second wave' of potential customers for the scheme: the bore water users in Angle Vale who missed out on the initial allocations and are now lobbying for an extension of the pipeline to their properties.(3) Looking at the range of data relating to this development, it may be asked, structurally, can the VPS accommodate the initial 3 GL/a that is expected to flow to that district and any further expansion of the customer base? Although SA Water had anticipated that 30 GL/a could flow through the VPS, it is reported that the figure is currently around 14.5 to 15 GL/a. However, peak demand is over the summer and part of the shoulder seasons, and there are days when the DAFF plant almost reaches its design capacity (120 ML/d). In addition, there will be another 400 ML/a (approx.) flowing from the DAFF plant to Mawson Lakes early this year, requiring approximately 2.5 ML/d over the peak summer months. A few growers report that some areas of the pipeline cannot cope with the peak demands, causing either a slowing of the flow or the pipe to shudder.

Additional water use is allowed, by arrangement, over and above allocated quantities of reclaimed water during the peak season. Although some growers may have generously estimated annual demand to get the scheme implemented, and others over-estimated due to the limitation of the daily flow rate, to ensure they had sufficient water across the summer season, few could afford to allow for the peak flows required. To do this they would have needed to size their annual allocation so that their daily limit of 0.54% gave them access to those high levels of demand when required. However, because the scheme is not yet to capacity, some broad acre and perennial growers report that they have been permitted to remove the plate that

restricts the daily flow. Therefore the peak demand occasionally experienced at the DAFF plant may be artificially inflated. When growers are required to pay for the excess drawn over their allocation, they may not take as much. This of course will depend on the cost involved and, according to the WRSV Contract, quoting 1997 prices, there is only a 1.15 c/kL additional charge involved, although this jumps to 28.5 c/kL for unauthorised water use during summer (WRSV 1997:12). Therefore, it will remain to be seen whether existing growers will continue to access the higher volume of water when required when they have to pay for the additional water used.

In discussions with growers and advisers, there is an acknowledged lack of cooperation within the Virginia horticulture community (3) which, at the same time, is prepared to 'pull together' when threatened from outside. This culture may change to a more proactive situation if a collaborative effort is made by supporting agencies to encourage a stronger and coordinated community partnership. For example, if the growers are clear about what is happening to the environment and how it affects their production, then they may be amenable to cooperating with government and other agencies to address the concerns of the region. Additionally, if there is discontent with the VPS contractual restrictions, then open communication allowing grower feedback and a review of the arrangements would help to reassess the current situation now that the scheme has operated for five years. Any adjustments made to water allocations may free up water wanted by others, such as the Angle Vale producers. Clearly, the ultimate 30 GL/a goal for the scheme will not be realised unless winter storage is available and this is currently being investigated through ASR research.

Finally, information transfer is crucial to the sustainability of the VPS and therefore the region. The VHC has demonstrated that it plays a key role in distributing information and providing education and services to the Virginia horticulture community. It is suggested that it may receive further support and provide a wider range of services if an evaluation could be conducted with growers to determine the preferred avenues for them to access information and training. The data suggests that printed information is not the preferred method for communication and as a result is not commonly digested. This reflects the literature, which finds that multiple sources of information and methods of outreach are needed for effective communication. Also, the continuation of a full-time bi-lingual interpreter would be necessary to maintain information transfer as outlined in the Monash University report (undated). To further build trust that fosters community partnerships, WRSV may benefit from having a presence within the VHC building instead of retaining a separate shop front. The company may help offset the government dominated image the centre has for some, while making WRSV services and information more accessible to growers.

6 Conclusion

It is claimed by a horticulture adviser and established grower that the VPS has been very successful in bringing people back into the district, making growers drought proof and sustainable (44:384; 27:28). These sentiments resonate with other growers' expressions already mentioned that positively reflect on the social impact of the scheme. For example: "Thank God!"; "Bolivar water – yippee!"; "For me, personally, it has been a godsend."; "Delighted". Growers interviewed who are connected to the VPS confirm that they appreciate Class A reclaimed water as much as they value other sources of water.

In terms of public health, the strategies that were implemented on the introduction of the water appear to have allayed concerns. There is however a level of background 'noise' relating to the potential long term effects of growing food crops with reclaimed water. It is noted that QA advisers and wholesalers have no up to date information on recommended practices for growers and general information relating to reclaimed water. Some horticulture and irrigation advisers also appear to lack information in relation to the VPS. Ongoing information is required so that all stakeholder groups can make informed opinions and decisions in relation to reclaimed water irrigation practices. It is important to maintain stakeholder confidence in the use of reclaimed water for the production of food crops. The safety aspects of reclaimed water will be foremost in consumers' consideration of the practice.

There was a strong expression of need for additional water over and above allocations during the peak growing season. However, growers do acknowledge that this is not necessarily possible due to the capacity limit of the pipeline. There are calls for a review into the allocation of the water now that the scheme has had five years' operational experience. Some growers wish to reduce their allocation. This may free up availability of water for new customers, for example, those waiting for the Angle Vale extension. The overriding message is that a 'user pays' system would be preferred to 'take or pay' as some growers are paying for water they are not using.

Growers reported few changes in relation to management practices that specifically involve reclaimed water. There is still general concern about salinity issues, although these may not relate directly to reclaimed water. Salinity is an ongoing problem in the region and is a difficult issue to address, as there are several potential contributing factors. These include the rising water table, existing saline bore water, questionable fertiliser and soil ameliorant use, and efficiencies relating to the volume of water applied.

Many of the stakeholders agree that there needs to be a coordinated approach to monitoring and reporting of data in the region in order to achieve sustainability. There is a standard IMP in place, however a more holistic view is required which takes into account all inputs and outputs of water, as well as all the roles and responsibilities of agencies and individuals involved in irrigation management including the growers. A community-based approach to investigate irrigation efficiencies and manage groundwater resources has been trialed in other regions, with successful outcomes that could be introduced on the NAP.

After five years' experience of reclaimed water irrigation, Virginia growers in various ways state that they value the water; QA advisers and wholesalers discern no difference between crops grown with reclaimed water and other water sources; and the two major retailers contacted confirm their policy of acceptance provided the current level of quality control is maintained.

7 Recommendations

The following recommendations are made for consideration by all the stakeholder groups involved in the implementation of recycled water schemes. Where possible, all stakeholders (particularly growers) should be involved in decision making and implementation of strategies to ensure community ownership of the processes and outcomes.

1. Review the pricing structure particularly relating to 'take or pay'.
2. Make provision for a review of water allocations in 'take or pay' schemes.
3. All stakeholder groups (including growers) should be involved in investigations to lower salinity levels in reclaimed water.
4. Discussions should commence with growers and relevant state agencies to establish an irrigation monitoring network (eg ground water monitoring) and irrigation scheduling technologies (eg CSIRO's Full Stop system).
5. Assess the most effective method for communication with different ethnic groups. This may include the continued employment of a bi-lingual or multi-lingual community liaison officer (full time) to build links within the community.
6. Provide a targeted education programme on reclaimed water and particular features of the scheme, including contractual documents, for people associated with giving advice to growers and developing policies relating to irrigation and environmental management.
7. Ensure that there is ongoing information readily available on reclaimed water in general and the scheme in particular for all stakeholders.
8. Determine the most appropriate methods for training for growers in the areas concerned. The study indicates that more participatory styles of teaching are suitable to ensure practices reflect learning preferences.
9. Provide opportunities for new entrants into horticulture to access training specifically relating to reclaimed water and provide follow up training and information for growers on an ongoing basis after connection to reclaimed water to keep them informed and to clarify any misunderstanding of contract rules.
10. Continue to investigate alternative market opportunities for crops that are irrigated with reclaimed water.
11. Ensure that findings related to consumers' perceptions of reclaimed water are communicated to all stakeholders to ensure continued market stability.
13. To assist with the transfer of information between growers and between various agencies and organisations, consider locating all local services that relate to reclaimed water in the one building.

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FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

Department of Sociology
Faculty of Social Sciences

GPO Box 2100
Adelaide 5001
Australia

Telephone: (+61 8) 8201 2026
Fax: (+61 8) 8201 3521
Email: sociology@flinders.edu.au

VIRGINIA PIPELINE SCHEME: YOUR EXPERIENCE

A team from the Department of Sociology at Flinders University is currently researching the experience and perceptions of people who are using reclaimed water for the irrigation of food crops, as well as wholesalers, retailers, managers of the Virginia Pipeline Scheme (VPS), and experts in policy making.

The project is being funded by Land and Water Australia, as part of The National Program for Sustainable Irrigation. It aims to learn form people's experiences of the VPS to highlight any improvements and identify what has worked well.

The Interview
The interview should take no longer than 40 minutes. The types of questions you may be asked are:

- How and when you first became aware of reclaimed water.
- A brief account of your experience in relation to the VPS.
- The types of information provided when you first considered connecting to the VPS.
- What motivated you to connect.
- The benefits of using reclaimed water, based on your experience.
- From your experience, how well the service has gone overall, any problems experienced and whether the existing system could be improved.

Confidentiality
All discussions and reporting will be confidential so that no individual will be identified, unless the participant wishes to be named. This is achieved by reporting data for groups, or giving individuals a fictitious name and changing other details if necessary.

Contacts
If you have any questions relating to this research, please contact June Marks at Flinders University – Department of Sociology on 8201 2628 or june.marks@flinders.edu.au, or Katherine Boon on 8388 4329 or 042 398 4710.

December 2004

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee. The secretary of this committee can be contacted on 8201 5466, fax 8201 2035 or Sandy.Huxtable@flinders.edu.au.

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

Department of Sociology
Faculty of Social Sciences

GPO Box 2100
Adelaide 5001
Australia

Telephone: (+61 8) 8201 2026
Fax: (+61 8) 8201 3521
Email: sociology@flinders.edu.au

CHƯƠNG TRÌNH CẤP NƯỚC TÁI CHẾ VIRGINIA : KINH NGHIỆM CỦA QUÍ VỊ

Một nhóm nghiên cứu thuộc Khoa Xã Hội Học, Trường Đại học Flinders đang điều tra về kinh nghiệm thực tế và ý kiến của những người sử dụng nước tái chế vào việc tưới cây trồng làm thực phẩm, cũng như của những người cung cấp nước sỉ và lẻ, các nhà quản lý của Chương Trình Cấp Nước Tái Chế Virgina (VPS) và các chuyên gia hoạch định chính sách.

Đề tài này được tài trợ bởi Chương trình Đất và Nước (Land and Water) Australia, và là một phần thuộc Chương trình Quốc gia về Tưới Tiêu Bền Vững (Sustanable Irrigation). Đề tài có mục tiêu thu thập ý kiến của cộng đồng về VPS, để làm rõ mọi tiến bộ và xác định điều gì đã được thực hiện tốt.

Việc phỏng vấn
Mỗi cuộc phỏng vấn sẽ không dài quá 40 phút. Quý vị có thể được hỏi các câu hỏi như sau:

- Lần đầu tiên quý vị được biết về nước tái chế bằng cách nào và từ bao giờ.
- Nói ngắn gọn về các kinh nghiệm thực tế của quí vị có liên quan đến VPS.
- Quý vị đã được cung cấp những thể loại thông tin gì khi quí vị bắt đầu tính đến việc nối đường ống với VPS.
- Động cơ gì khiến quý vị nối đường ống.
- Các lợi ích của việc dùng nước tái chế, căn cứ trên kinh nghiệm thực tế của quý vị.
- Theo kinh nghiệm thực tế của quý vị thì dịch vụ này nói chung tốt đến mức độ nào, có những vấn đề khó khăn gì và hệ thống hiện tại còn có thể được cải tiến tốt hơn hay không.

Việc bảo mật
Mọi cuộc trao đổi và báo cáo đều sẽ được bảo mật để không tiết lộ danh tính cá nhân trừ khi người được phỏng vấn muốn được nêu rõ tên. Việc bảo mật thực hiện bằng cách báo cáo kết quả theo nhóm, hoặc đặt tên giả, hoặc thay đổi các chi tiết khác nếu cần thiết.

Cách liên lạc
Nếu quý vị có bất cứ câu hỏi nào liên quan đến nghiên cứu này xin liên lạc với June Marks, Khoa Xã hội học, Đại học Flinders, theo số 8201 2628 hay june.marks@flinders.edu.au, hoặc với Katherine Boon điện thoại 8388 4329 hay 042 398 4710.

Tháng 12/2004

Đề tài nghiên cứu này đã được Hội đồng Đạo đức về Nghiên cứu Hành vi và Xã hội thuộc Đại học Flinders thông qua. Xin liên lạc với thư ký của hội đồng này qua 8201 5466, fax 8201 2035, hoặc Sandy.Huxtable@flinders.edu.au.

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

Social and Behavioural Research Ethics Committee

GPO Box 2100
Adelaide 5001
Australia

Telephone: (+61 8) 8201 2026
Fax: (+61 8) 8201 3521

CONSENT FORM FOR PARTICIPATION IN RESEARCH

I .....

hereby consent to participate as requested in the Information Sheet for the research project on my experience of the Virginia Pipeline Scheme.

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I agree to my information and participation being recorded on tape.
4. I am aware that I should retain a copy of the Information Sheet and Consent Form for future reference.
5. I understand that:
   - I may not directly benefit from taking part in this research.
   - I am free to withdraw from the project at any time and am free to decline to answer particular questions.
   - While the information gained in this study will be published as explained, I will not be identified (unless I give express permission, having sighted a draft of the publication), and the research team (Dr Maria Zadoroznyj, Dr June Marks and Katherine Boon) will ensure that individual information will remain confidential.
   - I may ask that the recording be stopped at any time, and that I may withdraw at any time from the session or the research without disadvantage.
   - I understand a transcript will be provided of the interview for my perusal, comment, or correction if necessary.

Participant's signature..... Date December 2004

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name .....

Researcher's signature.....Date... December 2004

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

Social and Behavioural Research Ethics Committee

GPO Box 2100
Adelaide 5001
Australia

Telephone: (+61 8) 8201 2026
Fax: (+61 8) 8201 3521

ĐƠN CHẤP THUẬN THAM GIA CUỘC NGHIÊN CỨU

Tôi tên là .....

đồng ý tham gia vào đề tài nghiên cứu về những kinh nghiệm thực tế của tôi đối với Chương Trình Cấp Nước Tái Chế Virgina, theo như yêu cầu trong Tờ Thông tin Chi Tiết.

1. Tôi đã đọc những thông tin được cung cấp.
2. Tôi đã được giải thích rõ về các chi tiết của quá trình nghiên cứu và mọi rủi ro liên quan.
3. Tôi đồng ý với việc ghi âm các thông tin và sự tham gia của tôi.
4. Tôi hiểu là sẽ phải giữ lại một bản lưu của Tờ Thông tin Chi tiết và Đơn Chấp thuận để làm tài liệu tham khảo trong tương lai.
5. Tôi hiểu rằng:
   - Tôi có thể không có lợi ích trực tiếp trong việc tham gia vào cuộc nghiên cứu này.
   - Tôi có quyền rút khỏi cuộc nghiên cứu này vào bất cứ lúc nào và có quyền không trả lời những câu hỏi nhất định.
   - Khi thông tin thu thập từ nghiên cứu này được công bố thì danh tính của tôi sẽ không bị tiết lộ (trừ khi tôi cho phép sau khi được xem bản nháp của công trình sẽ được công bố), và nhóm nghiên cứu (Dr Maria Zadorojnyj, Dr June Marks và Katherine Boon) sẽ phải đảm bảo là mọi thông tin cá nhân sẽ không được tiết lộ.
   - Tôi có thể yêu cầu dừng việc ghi âm vào bất cứ lúc nào, và có thể rút khỏi cuộc phỏng vấn hay cuộc nghiên cứu này bất lúc nào mà không bị thiệt hại.
   - Tôi hiểu là tôi sẽ được cung cấp biên bản của cuộc phỏng vấn để đọc, nhận xét, hay sửa chữa nếu cần thiết.

Chữ ký người tham gia ..... Ngày... 12/2004

Tôi xác nhận là tôi đã giải thích về nghiên cứu này cho người tình nguyện tham gia và tôi cho là quý vị này đã hiểu được các vấn đề liên quan đến cuộc nghiên cứu và tự nguyện đồng ý tham gia.

Tên người nghiên cứu Katherine Boon

Chữ ký người nghiên cứu..... Ngày .../12/2004

WATER QUALITY

The water is suitable for irrigation purposes but is not to be used for drinking, swimming, food preparation, packaging, for in-home or home garden purposes, for drinking by livestock or for production of food grade aquaculture.

PERSONAL HYGIENE

Though Class A reclaimed water represents a negligible risk to the public through irrigation of food crops, sound hygiene practice is recommended for those with regular contact/exposure to reclaimed water.

- **Wash hands well with soap before eating, drinking or smoking and at the end of the working day**
- **Do not consume food or drink, and do not smoke while working with reclaimed water**
- **Wear/use clothing and equipment appropriate to tasks being undertaken**
- **Do not drink reclaimed water and avoid high exposure and inhalation of spray**
- **Ensure that employees, workers and visitors who may come in contact with reclaimed water are advised accordingly.**

WATER FLOWS AND NO DIRECT COUPLING

Customers are not permitted to direct-couple pumps and other pipes to the Virginia Pipeline. Water from the pipeline must be able to flow freely into storage with an air gap between the end of the pipe and the customer storage and there must be no opportunity for water in the customer storage to flow back into the Virginia Pipeline.

On-farm reclaimed water piping systems must not be connected to other water supply systems, e.g. drinking water without a backflow prevention system as specified in AS3500.

SPRAY DRIFT CONTROL

There are no specific restrictions to control airborne drift when using Class A reclaimed water. However, spray irrigation is to be undertaken in a manner that prevents spray drift or application beyond your property boundary.

DRINKING WATER BORES

Bores are extensively used in the Virginia triangle for supply of potable water. The Virginia Pipeline Scheme Irrigation Management Plan extensively details a monitoring programme that will determine the effect if any of Virginia Pipeline water on ground water, soil and crops.

Bores and borewater supplies used for drinking should be protected from contamination by reclaimed water.

WASHING OF PRODUCE

International fresh food regulations do not permit the use of reclaimed water for final washing of produce or processing of food before sale. However, there is no specific requirement to wash produce before sale but in the event that this is done, non-reclaimed water must be used.

HYDROPONIC PRODUCE

Use of the reclaimed water for food chain hydroponics will require further treatment by reverse osmosis or an equivalent process authorised by the SA Health Commission.

FARM STORAGE

Unlined storages of Virginia water are to be located at least 50 metres from any on-farm waste water disposal system, e.g. septic tanks. On-site storages are to be designed and operated to provide effective control of mosquito breeding and any offensive odour.

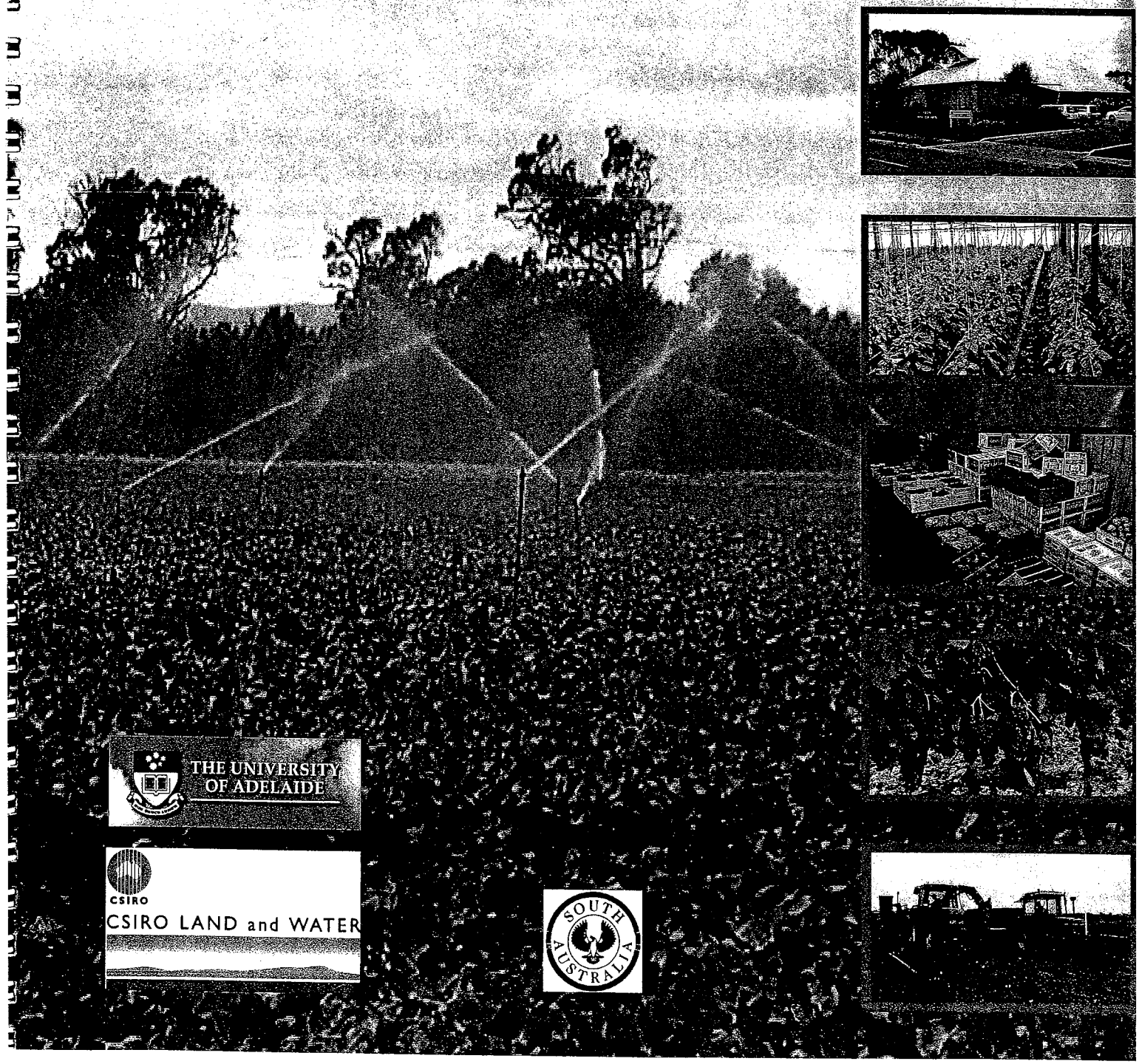
PIRSA RURAL SOLUTIONS

Sustainable Use of Reclaimed Water on the Northern Adelaide Plains

Grower Manual

Natural Heritage Trust

Helping Communities Helping Australia



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SOUTH AUSTRALIA

Tập Thông Tin Về Nước Tái Chế

Chủ Đề	Các Điểm Chính
Giới Thiệu Xem Tập Thông Tin Về Nước Tái Chế, trang 2	Nước Tái Chế Loại A (Class A Reclaimed Water – CARW) • Là nước thải được xử lý lần thứ ba theo phương pháp Làm Nổi Bằng Khí Hoà Tan và Lọc (Dissolved Air Flotation and Filtration – DAFF) • Bộ Y Tế Nam Uc đãchấp thuận cho sử dụng không hạn chế CARW làm nguồn nước tưới. • CARW phù hợp với các quy định nghiêm ngặt nhất của thế giới về chất lượng, sức khoẻ và sự an toàn đối với các mục đích tưới tiêu không hạn chế. Bộ Y Tế Nam Uc kiểm tra nước hàng tuần để bảo đảm chất lượng. **Nông gia có thể hoàn toàn tin tưởng trong việc sử dụng CARW** CARW đang và sẽ mang lại lợi ích về kinh tế và môi trường cho nông gia ở Vùng Đồng Bằng Bắc Adelaide (Northern Adelaide Plains – NAP). Với mức độ sử dụng hiện nay, việc chỉ phụ thuộc vào nguồn nước ngầm ở NAP là không ổn định.

Chủ Đề	Các Điểm Chính
Trừ Tảo Ở Các Đập Nước Trong Trang Trại Xem Tập Thông Tin Về Nước Tái Chế, trang 4.	Hoa tảo (Algal Blooms) gây ra nhiều trở ngại tại các đập giữ CARW và, trong một vài trường hợp, tại các nguồn nước ngầm. Điều này đã dẫn đến những vấn đề liên quan đến các thiết bị tưới tiêu và sự lo ngại về chất lượng sản phẩm. Tảo là các tổ chức đơn bào sống như thảo mộc. • Để phát triển, chúng cần ánh sáng mặt trời, nước và các chất dinh dưỡng. **Biện pháp diệt trừ** (Xem Biểu Đồ về Phương Pháp Phòng Trừ trong trang 7 của Tập Thông Tin) **Diệt trừ bằng phương pháp vật lý** • **Giảm ánh sáng mặt trời đến mức tối thiểu:** - nếu có thể làm được thì che phủ mặt nước trên đập, dùng ống dẫn nước có màu sẫm. Nếu khả thi thì đây là phương pháp hiệu quả nhất. • **Khấy trộn và thay khí trong đập:** - dùng không khí để trộn nước lạnh ở bên dưới với nước ấm ở bên trên. Chỉ nên dùng biện pháp này ở các đập sâu. Nếu khuấy quá mạnh thì có thể sẽ làm xáo trộn lớp cặn dưới đáy và làm tăng lượng phốt pho (phosphorus). • **Thay đổi tỷ lệ dòng chảy:** - sự thay đổi tỷ lệ sử dụng dòng chảy có thể hạn chế được sự phát triển của tảo vì nó làm cho điều kiện phát triển của tảo trở nên bất ổn. • **Thiết bị lọc:** - dùng các thiết bị lọc như lọc màng, lọc lưới và lọc carbon để loại trừ tảo. Cách làm này sẽ làm tăng hiệu quả kinh tế và tưới tiêu. • **Bố trí dòng thoát:** - việc bố trí dòng thoát ở dưới mặt nước nhưng không sát đáy có thể hạn chế được sự lấn chiếm của tảo. • **Bảo vệ dòng thoát:** - lập hàng rào nổi để bảo vệ cho dòng nước thoát ra khỏi bị ô nhiễm. **Diệt trừ bằng cách hạn chế chất dinh dưỡng** CARW chứa nồng độ nitrogen và phosphorus lớn hơn nhu cầu của hoa tảo, vì vậy, trừ tảo bằng cách hạn chế chất dinh dưỡng trong CARW trở nên không thực tế và không có hiệu quả kinh tế. **Diệt trừ bằng hoá chất** Đây có lẽ là phương pháp diệt trừ có hiệu quả nhất trong thời gian ngắn. • **Thuốc diệt tảo:** - đây là giải pháp có lợi nhất cho những đợt bộc phát của tảo. (xem phần tóm tắt về các hoá chất phù hợp và cách sử dụng trong trang 7 của Tập Thông Tin) **Biện pháp phòng trừ tốt** sẽ cho phép người sử dụng giảm thiểu sự phát triển của tảo.

Tập Thông Tin Về Nước Tái Chế

Chủ Đề	Các Điểm Chính
Các Loại Đất ở NAP và Sự Tương Tác Của Chúng Đối Với Nước Tái Chế. Xem Tập Thông Tin Về Nước Tái Chế, trang 8	Việc thử nghiệm đất tiến hành ở NAP cho thấy nồng độ chất dinh dưỡng có trong đất có thể độc hại đối với cây trồng. Nông gia cần xác định nồng độ chất dinh dưỡng của đất và cây bằng các thử nghiệm về đất và mô lá. Việc này sẽ giúp sử dụng phân bón có hiệu quả nhằm đạt sản lượng tối đa. **Chú ý** • Dùng phân quá nhiều thường làm giảm chứ không tăng năng suất. • Tất cả các cuộc thử nghiệm đất mới đây tiến hành ở NAP cho thấy nồng độ potassium (K), sodium (Na) và độ mặn cao. • CARW có chứa số lượng lớn nitrogen (N) và phosphorus (P). Do đó, có lẽ cần phải cân nhắc vấn đề này trong kinh phí cho phân bón. Xin liên lạc với Phòng Nông Nghiệp Virginia (Virginia PIRSA Rural Solutions Office) tại Virginia Horticultural Centre để được hướng dẫn về thử nghiệm đất và mô lá cùng các chương trình phân bón. (8282 9200) **Bằng việc quản lý đất có hiệu quả nông gia có thể kết hợp lợi ích của nghiên cứu khoa học với kiến thức thực tế để đạt tối đa năng suất và chất lượng nhưng đồng thời vẫn duy trì được sự ổn định của môi trường.**

Chủ Đề	Các Điểm Chính
Đánh Giá Độ Mặn Của Đất Xem Tập Thông Tin Về Nước Tái Chế, trang 13	**Độ mặn là gì?** Là một tính chất được thể hiện bằng tổng số lượng muối hoà tan được trong nước có trong đất. **Đất nhiễm mặn** Là đất có chứa lượng muối hòa tan đủ để gây ảnh hưởng xấu đến năng suất của đất. **Đo độ mặn của đất** Đo độ dẫn điện của hỗn hợp đất và nước ở thể vẫn với tỷ lệ 1:5 ($EC_{1:5}$) là một phương pháp tiện lợi để đánh giá hàm lượng muối trong đất. Đơn vị đo là deci-Siemens/mét (dS/m). Dựa trên các chất chiết ra từ đất nhão đã bão hòa (EC_e) người ta biết được khả năng chịu mặn của cây trồng. Công thức chuyển đổi: $EC_{1:5} \times 8,2 \sim EC_e$ Xem phần **Hướng Dẫn Đánh Giá Độ Mặn Của Đất** trong trang 13 của Tập Thông Tin. Xem phần **Khả Năng Chống Chịu Tương Đối Của Cây Trồng Đối Với Độ Mặn Của Đất** trong trang 14 của Tập Thông Tin. **Kiểm Tra Đất và Mô Lá** là chìa khóa để **Hạn Chế Độ Mặn Có Hiệu Quả** • Chọn loại cây thích hợp có khả năng chịu được độ mặn của đất (Xem trang 14 của Tập Thông Tin). • Ngăn chặn sự nhiễm mặn bằng cách dự tính tỷ lệ rửa mặn để loại bỏ lượng muối tích tụ. • Chọn loại đất thích hợp để tưới tiêu. Hãy tính đến: – loại đất và các tính chất chuyển động của nước đi qua đất – độ sâu của mực nước ngầm