Wastewater irrigation management plan (WIMP)

—a drafting guide for wastewater irrigators

Updated June 2009[1]

EPA 793/09: This drafting guide is developed to assist licensees develop a wastewater irrigation management plan that meets a standard acceptable to the Environment Protection Authority (EPA). This guide will advise unlicensed facilities in developing a plan for the sustainable application of wastewater to land in accordance with environmental legislation[2]*.*

Introduction

This guideline aims to provide guidance and criteria for the sustainable irrigation[3] of organic, nutrient-rich or saline wastewater, such as from milk processing, cheese manufacturing, saleyards, abattoirs, wineries, and olive, vegetable and fruit processing facilities.

For urban-based activities, disposal to a sewer (with SA Water approval) is a practical option, although it may come at a cost related to pollutant loads in the wastewater. For rural locations where disposal by irrigation is the only practical option, an adequate level of planning and management is needed to ensure that the irrigation is sustainable.

The Environment Protection Authority (EPA) views wastewater management as an integral component of a company's operational processes and budget. The EPA also advocates wastewater as a nutrient-loaded resource that, with suitable treatment, can be a valuable asset to the company. However, wastewater reuse require a sophisticated level of understanding of soil, wastewater and crop dynamics, and a commitment to various levels of ongoing monitoring and assessment.

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1 First issued April 2008.

2 Relevant legislation and publications are provided at the end of the guideline.

3 Even with 'sustainable' irrigation practices, wastewater cannot be applied to land indefinitely. Over time, soil structure may slowly decline, and nutrients or salt may accumulate. Less severe problems can be remedied by cultivation and soil treatment. However accumulation of excess substances in the soil, eg phosphorus can only be addressed by stopping wastewater irrigation and changing cropping practices until the concentrations are reduced by crop removal.

A wastewater irrigation management plan (WIMP) should be considered as a necessary environment management tool for a company to:

- demonstrate that all reasonable and practicable steps have been taken to meet the environmental duty of care, and
- maximise cash returns from the wastewater-irrigated crop while minimising the impacts on the receiving environment.

Objectives of the WIMP

Developing and implementing a WIMP will help to:

- minimise the risk of polluting surface and groundwater resources by preventing wastewater runoff or excessive infiltration
- minimise soil degradation and damage to crops by using sustainable irrigation application rates, based on soil limitations (as per soil survey) and crop requirements
- prevent environmental nuisance by identifying wastewater pre-treatment requirements and employing suitable separation distances for irrigation
- prevent public and animal health impacts by using appropriate irrigation equipment, and implementing training and awareness programs for staff
- maximise organic carbon, nutrient and salt removal by selecting suitable land, viable and tolerant crops and suitable cropping practices.

Legislation

The principal legislation that addresses pollution in South Australia is the *Environment Protection Act 1993* (the EP Act). In particular, section 25 of the Act imposes a general environmental duty on anyone who undertakes an activity that pollutes, or has the potential to pollute, to take all reasonable and practicable measures to prevent or minimise environmental harm. An offence may occur if poor wastewater irrigation practices lead to migration of chemical substances, nutrients or salts to soil, groundwater or surface waters (eg rivers, streams, wetlands, estuaries, coastal habitats). In addition, odour generation from wastewater irrigation may constitute environmental nuisance under section 82 of the Act.

The *Environment Protection (Water Quality) Policy 2003* (WQ Policy) provides water quality criteria for receiving waters in South Australia into which discharge is released. It is unlikely that these criteria would be met even after extensive treatment of wastewater, and under the WQ Policy it is an offence to discharge certain pollutants (listed in Part 1 of Schedule 4) onto land where it may enter waters. Therefore, to prevent an offence against the WQ Policy, wastewater irrigation **must** only be applied within the limits set by antecedent soil moisture levels, soil infiltration rates and likely rainfall conditions. Division 2 of the WQ Policy also imposes an obligation on particular industries to incorporate a wastewater management system. The development of a WIMP is a necessary component of the wastewater management system for any facility that irrigates wastewater on site. Only by doing all this will wastewater irrigation practices comply with the WQ Policy for discharges to surface water and groundwater.

When is the WIMP required?

The EPA licenses some of the activities already described, and licence conditions can require that a WIMP be developed for wastewater irrigation. The WIMP may be a stand-alone document, or part of a holistic environmental management plan or environmental performance agreement.

Companies and individuals who are not licensed by the EPA may develop a WIMP to minimise their impact on the environment and to comply with the general environmental duty (Section 25) of the Act and provisions of the WQ Policy.

Risk assessment and preliminary investigations

A risk assessment[4] based on the soils, site constraints, wastewater characteristics and potential health impacts will guide the level of planning and management required. The National Water Quality Management Strategy (NWQMS) *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)* [2008] outlines a risk-based framework for management of recycled water quality and use. It can be accessed at <www.ephc.gov.au/sites/default/files/WQ_AGWR_GL__Managing_Health_Environmental_Risks_Phase1_Final_200611.pdf>.

The NWQMS Guidelines focus on two specific situations—water recycled from centralised sewage treatment plants and from greywater. However, the framework could also be applied to industrial wastewater generated by activities described above. The NWQMS Guidelines is available on <www.ephc.gov.au/taxonomy/term/39>.

The Department of Health (DH) also requires users of recycled water from municipal wastewater treatment plants and/or community wastewater management systems(CWMS) for high exposure applications such as unrestricted irrigation to develop a recycled water risk management Plan (RMP).

A factsheet, *Recycled water systems: information guide for applicants* (2009) is available on <www.health.sa.gov.au/pehs/PDF-files/0903-Recycled-Water-Application-Guide.pdf>. This document provides guidance on the development of an RMP utilising the 12 elements of the recycled water quality management framework provided in the NWQMS Guidelines. Hence, the factsheet could also be used by industries when undertaking the risk assessment.

Development of a detailed WIMP may require specialist input particularly in the case of difficult soils or sites, or excessive nutrients and/or salts concentrations in wastewater. See later section for guidance on persons capable of providing assistance for initial guidance.

In addition, depending where your facility is in the state you are located, special rules may be applied through local Water Allocation Plans (WAPs). These may affect how or where irrigation of wastewater can take place, eg:

- in the Clare Valley, some restrictions may apply in catchments with rising saline water table issues

[4] Information on risk analysis and management can be obtained from the Australian Standard *AS 4360:2004 Risk Management*. The EPA has also developed a risk matrix for prioritising risks. This matrix is available on <www.epa.sa.gov.au/pdfs/poster.pdf>.

- River Murray and other areas may already have irrigation drainage management plans (IDMPs), developed for water licensing authorities, that detail soil limitations for irrigation. These can also be used as a basis for assessing risk with a limited, additional examination of soil fertility and wastewater quality.

Details of the local WAPs may be sourced from Department of Water, Land and Biodiversity Conservation <www.dwlbc.sa.gov.au/water/allocation_plans/index.html>.

Factors to consider

The following factors should be taken into account during risk assessment and when determining the best option to manage the risk:

- type and scale of the activity
- quality of wastewater to be used for irrigation, and variability in wastewater flow
- over-winter storage and requirements for flow equalisation, and the mixing of various strength wastewaters prior to treatment/disposal
- sensitivity of the site, eg location within a floodplain or water protection area, proximity to watercourses, depth to groundwater and seasonal water tables
- site topography and climatic conditions
- available land area for irrigation, adjoining land uses and buffer distances
- nature and properties of the soil
- available capital.

Preliminary soil investigations

All irrigators of treated or untreated wastewater are required to undertake some investigation of the proposed site to establish basic soil physical and chemical properties to enable risk assessment.

For larger volumes, highly concentrated wastewaters, more difficult sites, and areas that are more sensitive (eg shallow groundwater or close proximity to surface water), it is recommended that a detailed soil investigation is undertaken on existing and proposed new sites to establish homogeneity and probable sampling intensity, as set out in the *Australian Soil and Land Survey Handbook* (1988).

Sampling intensity is dependent on the uniformity of soils across the intended irrigation areas, eg:

- 75 x 75 metre grid spacing (cored or excavated to 2–3 metres) in drainage hazard sites
- 100 x 100 metre grid cored or test pits on moderately uniform sites
- a more open pattern where good soil homogeneity is evident.

Soil physical properties

The key physical properties that should be identified in initial soil investigations include:

- texture/structure
- topsoil depth
- depth to drainage or root impeding layers
- infiltration rates
- soil–water holding capacities [readily available water (RAW) values].

Soil chemistry

The accuracy of soil analytical data relies highly on the sampling methods and techniques employed, hence:

- soil sampling should be undertaken only by qualified professionals or suitably trained persons
- soil sampling should take into account relevant schedules of the *National Environment Protection (Assessment of Site Contamination) Measure 1999* to suit specific situations (eg Schedule B(2)—Guideline on Data Collection, Sample Design and Reporting)
- samples should be obtained from depths that correspond to horizontal stratigraphy to take into account the physical variations within the soil profile
- analysis of samples should be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA) <www.nata.asn.au> or with an acceptable quality management and assurance program, such as certification from the Australasian Soil and Plant Analysis Council (ASPAC) <www.aspac-australasia.com>.
- In addition**,** specific site history and conditions, the nature of wastewater to be applied and crop requirements, should be considered when determining the soil chemical parameters to be analysed in each location.

Preliminary site characterisation

The following information is essential to allow risk assessment:

- the slope and topography of the irrigation area (normally best presented using 1:10,000 topographic or orthographic map)
- soil homogeneity to determine appropriate sampling intensity
- history of waste storage or wastewater disposal on the irrigation site
- the depth to groundwater and seasonal or permanent water tables
- areas of drainage hazard or other impediments to irrigation, and where present, any contour banking or downslope dams
- separation distances from sensitive areas (eg watercourses, groundwater supply bores and dams, public access roads, neighbouring houses)
- **Appendix 1** provides indicative site limitation levels that will be useful in the selection of suitable wastewater irrigation sites.

Preliminary wastewater characterisation

All irrigators of treated or untreated wastewater are required to identify the wastewater characteristics to enable risk assessment to be made. **Appendix 2** provides general wastewater characteristics from differing sources. However, it should be noted that the nature of wastewater varies with the activities and processes used, and individual site conditions and practices.

The range of analytes listed in this table should be considered, although not all may be relevant for a particular site. Any other substances used in the facility (eg pesticides, cleaning and sanitation agents, product additives) that could affect soil, watercourses or living organisms should be included in the suite of analytes.

The following points should also be considered:

- wastewater should be sampled to comply with the Australian and New Zealand Standards (AS/NZS 5667:1998) and *EPA Guidelines: Regulatory monitoring and testing—water and wastewater sampling* (2007)

- samples should be analysed by a NATA accredited laboratory using accredited procedures to ensure the integrity of the data. The NATA website <www.nata.asn.au> contains a list of suitable accredited laboratories for wastewater analyses.

Schedule 2 of the WQ Policy provides water/wastewater criteria for irrigation purposes with respect to heavy metals and trace ions.

Potential health impacts

Proponents of integrated recycling schemes (eg combined domestic and industrial wastewater) will need to seek approval from DH. Similarly, wastewater from abattoirs and animal husbandry-type activities could result in the spread of pathogens and parasitic organisms. The recycling of treated wastewater from these activities will also need consultation with DH and Primary Industries and Resources SA (PIRSA) to address potential impacts to human and animal health.

Persons capable of providing assistance

The EPA recommends that only qualified and experienced consultants provide advice on wastewater pre-treatment and disposal by irrigation. These consultants are likely to be members of professional organisations such as the Australian Society of Soil Science Inc <www.asssi.asn.au>, the Australian Institute of Horticulture <www.aih.org.au>, the Australian Institute of Agricultural Science and Technology <www.aiast.com.au> or other scientific organisations or institutions.

Government organisations (such as PIRSA, CSIRO and SARDI) can provide background information and may also provide fee-for-service consultancies. A large number of local and interstate engineering and agricultural consulting firms can also provide further specialist advice and assistance.

The chosen consultant should be able to provide advice on soil surveys and interpretation, wastewater sampling, improvements to treatment systems, sustainable nutrient and salt loadings, crop management, irrigation scheduling and suitable irrigation and soil monitoring equipment and services, or work in partnership with qualified consultants in these areas.

Available models and information

WASTLOAD, a spreadsheet model for calculating the sustainable spreading rates of solid and liquid wastes has been developed by PIRSA to assist managers, consultants, planners and farmers. This is available from either <pirsa.on.net/resources/BookShop> or local PIRSA/Rural Solutions SA offices.

The *Manual for spreading nutrient-rich wastes on agricultural land* (2003), which accompanies this model, provides information and guidance on:

- the general principles of spreading wastes
- characteristics of wastes from various industries including piggeries, cattle feedlots, dairy sheds, wineries, olive processing and others
- allowable biochemical oxygen demand (BOD) application rates relative to soil types
- sodicity classes for irrigation waters
- land application methods
- potential health risks of land application.

Other similar models, eg MEDLI (Model for Effluent Disposal Using Land Irrigation), are also available for determining sustainable application rates.

For wineries, the *Winery Wastewater Handbook: Production, Impacts and Management* (2001) provides some useful information.

Rural Solutions SA have also published guidelines for dairies in many areas of the state, available from the dairy industry website <www.dairyindustrysa.com.au/technical_info_for_farmers/effluent_management>.

The WIMP documentation

For clarity purposes, the EPA considers that the following sections should be included in the WIMP. A checklist for required WIMP documentation is provided in **Appendix 3**.

Tracking and reference information

For effective record-keeping and communication, the first page of the WIMP should contain provisions for the following information:

- document number and date
- name of the licensee or operator and EPA authorisation number, if applicable
- location of the facility and irrigation areas
- person responsible for the document
- signature of the company manager or employee with proper delegation to indicate the company's commitment to the WIMP and the proposed actions.

Summary of risk assessment outcomes and proposed management approach

A detailed discussion should be provided outlining the findings of the risk assessment and strategies to address the risks. These should include:

- soil suitability or limitations for wastewater irrigation, and any soil treatment required to improve the soil
- limiting wastewater constituents for disposal to land, any pollutant reduction strategy or pre-treatment requirements, and the minimum land area required to remove the most limiting constituent
- hydraulic, organic, nutrient and salt mass balance calculations (kg/Ha/yr) that support the determination of limiting factors to crop growth, and long-term soil loadings[5]
- suitable crops, including harvesting requirements to prevent pollutant accumulation in soil and crops
- a sustainable application rate that maximises nutrient removal and water use efficiency
- a suitable soil moisture monitoring system to schedule irrigation to crop moisture requirements
- appropriate irrigation system layout, controllers and other equipment required to differentiate irrigation application rates between soils of varying capabilities
- the human resource and training requirement to operate and maintain the monitoring equipment and irrigation scheduling systems
- the capacity of the wastewater storage to cope with a 1:10 wet year, and any additional storage capacity requirement to cope with a 1:10 ARI storm of 20 minute duration falling on the catchment

[5] Note: to convert nutrient concentration to mass per hectare—every 1 mg/L nutrient concentration = 1 kg/Ha for each 100 mm of wastewater irrigation.

- potential long-term impact of wastewater irrigation on soil structure or nutrient accumulation.

Summary of intended actions

Some irrigation management issues may require additional time and resources. The future tasks that will be undertaken in order to address the outstanding findings of the investigations and meet the objectives of the WIMP should be outlined in a table. Include the target completion dates and the designated person responsible for each action. The actions should be unambiguous and clearly demonstrable. In the case of licensed facilities, this summary will assist the EPA in assessing compliance and ongoing performance.

WIMP Review

To ensure that the objectives of the WIMP are being met, the document should include instructions for the regular review of the document. Review should also occur when:

- there are changes to relevant processes or management practices on site
- there are changes in wastewater volumes or contaminant loading
- monitoring results show discrepancies with predicted outcomes.

Future management and remediation

The EPA recommends that a long-term plan be incorporated in the WIMP to address:

- the expected life of the area before nutrient accumulation or accession to groundwater occurs
- any necessary remediation of the area depending on future intended use
- potentially available sites for future expansion or relocation
- harvesting plans for woodlots, when the trees reach maturity.

Responsibilities in cases of disposal to another person's property

Where the operator intends to dispose of wastewater on land not owned by the company, the WIMP should describe the contractual arrangement with the property owner, in particular, the relationship in terms of responsibility for:

- preparation and review of WIMPs
- any monitoring, reporting and contingency requirements relating to EPA authorisations
- operation and maintenance of irrigation and monitoring equipment
- remedial actions if environmental harm or nuisance has been caused
- any public or animal health issues arising from use of the wastewater.

Other relevant documents

The following documents may be required from EPA licensed facilities as part of their regulatory requirements. These documents could be developed separately or specifically for the purpose of this WIMP. However, for many industries, these documents normally form part of the company's environmental management system. These documents (or preferably, the applicable sections of the documents) could be attached if relevant to the implementation of the WIMP.

Monitoring plans and reports

Conditions of EPA authorisations may also require monitoring and reporting plans be developed. Industry sector guidelines may also outline the monitoring requirements for certain activities.

The purpose of monitoring should be clearly stated and the monitoring requirements clearly defined. Wastewater irrigation monitoring may have multiple purposes, such as to:

- determine the hydraulic loading of the wastewater (irrigation depth in mm) and accompanying pollutant load (kg/Ha/yr)
- assess changes to soil structure and chemistry (initial soil testing and replications over several years of irrigation, dependant on wastewater strength and irrigation loadings)
- determine any localised groundwater mounding effects or potential pollution of groundwater
- monitor any potential odour generation arising from wastewater application
- facilitate the calculation of fertiliser requirements to supplement the available nutrients in the wastewater
- enable the calculation of nutrient harvesting efficiency from tissue analysis and tonnage of crop removed.

Reporting requirements will vary depending on the sensitivity of the site, wastewater strength and loading, storage requirements, and the potential for odour or noise nuisance.

All wastewater irrigators are encouraged to record any incidents (eg wastewater escape or pipeline breakages), nuisance complaints from neighbours, maintenance issues, the risk management decisions to address these issues, and any changes to normal disposal practises as a means of self-managing risk.

In addition, to derive maximum value from any environmental monitoring activity, monitoring summaries or reports should always include an interpretation of recent results, evident trends when compared with previous analysis and conclusions, and actions intended to manage any identified risks.

The *EPA Guidelines: Monitoring plan requirements* (2006) and *Reporting requirements* (2006) clearly outline the expectations of the EPA with regard to monitoring plans and reporting. They are available on the EPA website at <www.epa.sa.gov.au/pdfs/guide_mpr.pdf> and <www.epa.sa.gov.au/pdfs/guide_rr.pdf> respectively.

Maintenance program

To prevent incidents that may result in wastewater escape to the environment or crop damage it is necessary to incorporate the following into the standard maintenance procedures for the facility:

- the regular calibration of irrigation pumps, flow meters and other irrigation instruments
- routine checks for irrigation distribution uniformity
- visual checks for irregularities in crop growth
- the regular maintenance of irrigation equipment, controllers and related infrastructure.

Contingency plans

In addition to a maintenance program, large-scale wastewater irrigators require a spillage notification procedure and adequate contingency provisions to address unforeseen events which may lead to environmental harm or nuisance, including:

- the capture of potentially polluted runoff from wastewater-irrigation sites during heavy storms
- failure or breakdown of wastewater pumps, pipes or equipment
- power failure or interruption
- natural events such as floods and fires
- the discharge of hazardous substances to the wastewater stream
- malicious actions and vandalism.

An EPA Guideline, *Contingency plans—a guide for wastewater producers and wastewater treatment plant operators* (2009) is available to assist producers, treatment plant operators and irrigators at <www.epa.sa.gov.au/pdfs/guide_contingency.pdf>.

Lodging the WIMP

For facilities that are required to submit a WIMP, the EPA will review the document upon submission to assess whether the actions proposed satisfy EPA requirements that wastewater disposal can be achieved at the site with minimal risk of environmental harm.

The EPA may:

- accept the document or require further changes to the proposed actions and timelines to ensure that the actions will achieve the intent of the WIMP
- amend the company's environmental authorisation (if applicable) to require any major action that is necessary for the implementation of the WIMP (eg upgrade of the wastewater treatment system)
- require regular progress updates and undertake site inspections to monitor the implementation of the proposed actions.

If licence conditions are amended as outlined above, the operator **must:**

- undertake the actions proposed in the approved WIMP within the agreed timeframe, and
- notify the EPA of any proposed major deviation to the approved WIMP before undertaking these changes.

References and related reading

Allen RG, Pereira LS, Raes D and Smith M 1998, *Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements*, FAO Irrigation and Drainage Paper 56, Rome.

ANZECC & ARMCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment and Conservation Council, Canberra.

Chapman J, Baker P and Wills S 2001, Winery Wastewater Handbook: Production, Impacts and Management, Winetitles, Adelaide.

DHS & EPA 1999, *South Australian Reclaimed Water Guidelines,* Department of Human Services and South Australian Environment Protection Agency, Adelaide.

DH 2009, Recycled water systems: information guide for applicants, South Australian Department of Health, Adelaide.

Doorenbos J and Pruitt WO 1975, *Guidelines for Predicting Crop Water Requirements*, FAO Irrigation and Drainage Paper 24, Rome.

EPA 2003a, *Environment Protection (Water Quality) Policy 2003 and Explanatory Report,* South Australian Environment Protection Authority, Adelaide.

——2003b, *Odour assessment using odour source modelling*, South Australian Environment Protection Authority, Adelaide.

——2004a, *Nutrient movement through SA soil*, South Australian Environment Protection Authority, Adelaide.

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——2006a, *EPA Guidelines–regulatory monitoring and testing: monitoring plan requirements*, South Australian Environmental Protection Authority, Adelaide.

——2006b, *EPA Guidelines–regulatory monitoring and testing: monitoring report requirements*, South Australian Environmental Protection Authority, Adelaide.

——2007a, EPA Guidelines: Regulatory monitoring and testing: water and wastewater sampling, South Australian Environmental Protection Authority, Adelaide.

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——2007c, *Guidelines for separation distances*, South Australian Environment Protection Authority, Adelaide.

——2007d, *EPA Guidelines: Environmental regulation using a risk based approach—A guideline for EPA staff,* South Australian Environment Protection Authority, Adelaide.

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EPHC, NRMMC & AHMC 2006, *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1),* Environment Protection and Heritage Council, the Natural Resource Management Ministerial Council and the Australian Health Ministers' Conference, Canberra.

Goss P 2006, *Cleaner Production: It's easier than you think*, ASVO 2006 Proceedings presentation, Australian Society of Viticulture and Oenology, viewed 9 June 2009, Adelaide. <www.asvo.com.au/proceedings/?action=view&id=28>

Gunn GH, Beattie JA, Reid RE and van de Graaff RHM 1988, *Australian Soil and Land Survey Handbook, Guidelines for Conducting Surveys*, Inkata Press, Sydney.

PIRSA 2000, *Annual Irrigation requirements for perennial horticulture crops in South Australia, Technical Report 263* Second Edition, Primary Industries and Resources South Australia Irrigated Crop Management Services, Adelaide.

PIRSA 2000, *Grower Manual for the use of reclaimed water on the Northern Adelaide Plains*, Primary Industries and Resources South Australia, Adelaide.

PIRSA 2003, *Manual for spreading nutrient-rich wastes on agricultural land*, Primary Industries and Resources South Australia, Adelaide.

PIRSA 2001, *Sustainable Use of Reclaimed Water on the Northern Adelaide Plains—Grower Manual*, NHT Project No. 975416, Primary Industries and Resources South Australia Rural Solutions, Adelaide.

Websites

Rural Solutions publications are available at <www.ruralsolutions.sa.gov.au/markets/waste_management>.

EPA publications are available at <www.epa.sa.gov.au>.

FURTHER INFORMATION

Legislation

Legislation may be viewed on the internet at: <www.legislation.sa.gov.au>

Copies of legislation are available for purchase from**:**

Service SA Government Legislation Outlet 101 Grenfell Street Adelaide SA 5000	Telephone: Facsimile: Internet:	13 23 24 (08) 8204 1909 <shop.service.sa.gov.au>

For general information please contact:

Environment Protection Authority GPO Box 2607 Adelaide SA 5001	Telephone: Facsimile: Freecall (country): Internet: Email:	(08) 8204 2004 (08) 8124 4670 1800 623 445 <www.epa.sa.gov.au> <epainfo@epa.sa.gov.au>

TAPPENDIX 1 SITE LIMITATIONS IN RELATION TO WASTEWATER IRRIGATION[6]

Feature	Limitation			Risks
	Slight	Moderate	Severe	
Slope Flood irrigation Sprinkler, tanker Trickle, microspray	 <1% <6% <10%	 1–3% 6–12% 10–20%	 >3% >12% >20%	Excess run-off and erosion
Flooding	None–Rare	Occasional	Frequent	Limited irrigation opportunities, erosion, waterlogging, increased recharge
Distance to watercourses	> 200 m	100–200 m	50–100 m	Contamination by runoff
Landform	Hill crests, convex slopes and plains	Concave slopes, foot slopes	Drainage plains, incised channels	Erosion and seasonal waterlogging
Surface rock	Nil	0-5%	> 5%	Interferes with site preparation, shallow soil, increased runoff
Hydraulic conductivity (mm/hr) Topsoil Subsoil to 1 m	 20-80 20-80	 5-20 1-20	 < 5 <1	 Excess runoff Waterlogging, acts as a poor filter
Depth to watertable (m)	> 3	0.5-3	<0.5	Wetness, risk of groundwater contamination
Depth to bedrock (m)	> 1	0.5-1	<0.5	Restricts root growth, increased waterlogging, small soil-water storage
Available water-holding capacity (mm/m)	> 200	< 200		Little availability to hold water between irrigation

[6] Hird C, Thompson A and Beer I 1996, 'Selection and Monitoring of Sites Intended for Irrigation with Reclaimed Water', *Proceedings in WATERTECH*, Sydney, Australia, 27 & 28 May, 1996.

Feature	Limitation			Risks
	Slight	Moderate	Severe	
Salinity or EC (dS/m)	<2	2–8	>8	Excess salt restricts plant growth
P sorption capacity (mg P/kg)	> 1,000	200–1,000	<200	Leaching of P to groundwater
pH (in CaCl2)	4–9	3-4	<3 or >9	Reduced plant growth
ESP	0–5	5–10	>10	Structural degradation
CEC (cmol(+)/kg) (average 0-40 cm)	> 15	< 15		Limited ability to hold nutrients

APPENDIX 2 GENERAL WASTEWATER CHARACTERISTICS FROM DIFFERING SOURCES

Characteristic (mg/L unless specified)	Abattoir	Dairy Process	Dairy Shed	Distillery	Feedlot	Piggery	Secondary Treated Sewage	Winery
Total Solids		138–8,500		1,100–4,500		3,100–8,600		500-2,200
Suspended solids		24–5,700	2,400	5,000–30,000	1,000–13,000	447	25–40	60–2,000
Volatile solids		57–4,700			40-62	1,809		
Total Phosphorus (Total P)	30–40	11–160	26–110	100–400	26–440	44–80	6–12	1–33
Inorganic P (mg/L)						28		
Total Kjeldahl Nitrogen (TKN)	130–500	15–200	160–280	500–1,700	148–1,155	380–600	20–50	1–128
Ammonium-N (NH4-N)			84		220-816	249		
Potassium (K)		11-160	57–200	1,300–2,100	460–9,102	366–1,300	23	19–1,250
Sulphate (SO4)						26		4.8–230
Biological Oxygen Demand (BOD5)	50–3,000	470–4,790	1500–3,200	13,000–35,000	500	40	16.4-30	160–8,000
pH (units)		4–12	8	3–5	6.9–8.1	7.5-8	8.4	4–10
Electrical conductivity (EC, dS/m)		2.1	1.12–10.6		3.8–37.8	5.5–7.9	1.0	0.4–6.6
Copper						0.99		
Chloride		48–469	180	160	620–2,996	810	149	46–396

Characteristic (mg/L unless specified)	Abattoir	Dairy Process	Dairy Shed	Distillery	Feedlot	Piggery	Secondary Treated Sewage	Winery
Sodium Absorption Ratio (SAR)		17	4.3	8	4.6–22		5	1.3–16.8
Calcium (Ca)		57–112	<180	90–140	100	24–257	24	12–220
Magnesium (Mg)		25–49	27–200	70–100	72	64–111	5	2.7–50
Organic Carbon				1,000–15,000				230–6,810
Sodium		60–807	119–1,200	260–540	280	470–757	102	18–880
Zinc						1.84		

Sources:

Clark TJ 2003, *Manual for Spreading Nutrient Rich Wastes on Agricultural Land*, Rural Solutions SA, Clare.

Biwas TK and FR Higginson 1998, *Interpreting Soil and Irrigation Water Test Results—a guide to land and wastewater quality assessment*, NSW EPA, Bankstown NSW.

ARMCANZ and ANZECC 1997, *National Water Quality Management Strategy, Australian Guidelines for Sewerage Systems, Effluent Management*, Agriculture and Resource Management Council of Australia and New Zealand and Australia and New Zealand Environment and Conservation Council, Canberra, ACT.

Data obtained by Tonkin Consulting.

APPENDIX 3 WIMP CHECKLIST

Report section	*Requirements*
Report Identification	• EPA licence number • name of licensee or operator • address of licensed site and irrigation area location (land parcel identification numbers) • document number or version, date of submission • person responsible for document • signature of company manager or delegation (as per application or renewal form signature) • proposed date of WIMP review or update.
WIMP Objectives	What important issues are addressed by the WIMP? Are there serious consequences that need to be managed and are addressed by the WIMP, eg high salt loads, waterlogged soils in part of the irrigation area?
Background Information	• summary of location and sensitive receptors eg distance to neighbours, close proximity to ground or surface water • summary of facility, eg wastewater volumes, treatment processes • references to other documentation relied on in the WIMP.
Risk assessment and preliminary investigation results	• soil suitability or limitations and treatments/avoidance to overcome problem areas • limiting wastewater characteristics • hydraulic, organic, nutrient and salt mass balance • suitable crops for wastewater loads • sustainable wastewater irrigation rates • proposed irrigation system, eg drippers, soil moisture monitoring • storage and over winter storage capacity • potential long term impact on soil.
Intended actions	actions and target completion dates to be taken in response to investigation, eg gypsum application, laser levelling.
Future management and remediation plans	long term options, eg intended expansion of facility or throughput.