Environmental guidelines for new and existing piggeries

A Latto
John Noonan
R. J. Taylor

Follow this and additional works at: http://researchlibrary.agric.wa.gov.au/bulletins

Part of the Agriculture Law Commons, Animal Studies Commons, Bioresource and Agricultural Engineering Commons, Biosecurity Commons, Environmental Health Commons, Environmental Indicators and Impact Assessment Commons, Meat Science Commons, and the Water Resource Management Commons

Recommended Citation
IMPORTANT DISCLAIMER

This document has been obtained from DAFWA's research library website (researchlibrary.agric.wa.gov.au) which hosts DAFWA's archival research publications. Although reasonable care was taken to make the information in the document accurate at the time it was first published, DAFWA does not make any representations or warranties about its accuracy, reliability, currency, completeness or suitability for any particular purpose. It may be out of date, inaccurate or misleading or conflict with current laws, polices or practices. DAFWA has not reviewed or revised the information before making the document available from its research library website. Before using the information, you should carefully evaluate its accuracy, currency, completeness and relevance for your purposes. We recommend you also search for more recent information on DAFWA's research library website, DAFWA's main website (https://www.agric.wa.gov.au) and other appropriate websites and sources.

Information in, or referred to in, documents on DAFWA's research library website is not tailored to the circumstances of individual farms, people or businesses, and does not constitute legal, business, scientific, agricultural or farm management advice. We recommend before making any significant decisions, you obtain advice from appropriate professionals who have taken into account your individual circumstances and objectives.

The Chief Executive Officer of the Department of Agriculture and Food and the State of Western Australia and their employees and agents (collectively and individually referred to below as DAFWA) accept no liability whatsoever, by reason of negligence or otherwise, arising from any use or release of information in, or referred to in, this document, or any error, inaccuracy or omission in the information.
The purpose of these Guidelines

This document is one in a series of guidelines prepared for activities which may have a significant environmental impact and may require environmental impact assessment.

The purpose of these guidelines is to provide information to industry, developers, local and state government agencies, farmers and the community on the legal requirements and environmental management practices for piggery operations (new and existing) in Western Australia.

The pork industry is important to the economy of Western Australia. Intensive piggeries, where the animals are fed, watered and housed inside a building, produce considerable quantities of concentrated waste which has the potential to adversely affect the quality of water resources. Extensive piggeries, where pigs are essentially free range, also have the potential to adversely impact on water resources and may also cause land degradation when not carefully managed. Even with the best management practices, all piggeries have the potential to impact upon people living too close to the operation.

These guidelines consolidate and supersede Agriculture WA's Environmental Management Guidelines for Animal Based Industries – Piggeries, the Department of Environmental Protection's Environmental Code of Practice for Piggeries, and 1995 draft Environmental Code of Practice for Extensive Piggeries (unpublished), and are consistent with the Draft Effluent Management Guidelines for Intensive Piggeries, December 1995, which is part of the National Water Quality Management Strategy (NWQMS).

The guideline series are seen as negotiable documents which may be enhanced or amended on the basis of experience and new information. Your views on this document are welcome and constructive comments will be incorporated into periodic upgrades of the guidelines. Refer to Appendix 3 for relevant contacts.

Acknowledgments

The following people provided valuable insight into the pork industry in Western Australia or assisted in the preparation of these guidelines:

John Ferguson, Bruce Mullan, John Noonan and Hugh Payne, (Agriculture WA); Annette Latto and Ron Powell (Department of Environmental Protection, WA); Brian Devine (Health Department, WA); Jim Dixon (Soil Conservation Commission); Ray Claudius, Peter Ryan and Rueben Taylor (Water and Rivers Commission); Tim Shanahan (WA Municipal Association); Lea Newing (WA Pork Producer's Association); Liam Flanagan (Great Southern Pig Company); Rob Wilson (Wandalup Farms); Ken Boughton and Neil Ferguson (Westpork); Graeme Moore (Yarloop Piggery); Howard Bowland (WP Software); John Bush and Margaret Turpin (Auswest Ecology - Consulting Services).

Note: Mention of trade names does not imply endorsement or preference of any company’s product by Agriculture Western Australia or any other Government Agency, and any omission of a trade name is unintentional. Recommendations were current at the time of preparation of this publication.

© Copyright Chief Executive Officer, Agriculture Western Australia
Environmental Guidelines for New and Existing Piggeries

By: A. Latto, J.D. Noonan and R.J. Taylor

Editors: M Howes & J Rovis-Herman
Design: J.D. Noonan

Bulletin 4416
March 2000
Agriculture Western Australia

ISSN 1326-415X
## Contents

1: **INTRODUCTION**
- 1.1 Scope of these Guidelines 1
- 1.2 Background to the pork industry in Western Australia 1
- 1.3 Intensive pork production in Western Australia 1
- 1.4 Extensive pork production in Western Australia 2
- 1.5 Alternative straw based housing 2

2: **LEGAL REQUIREMENTS**
- 2.1 Approvals required to establish and/or operate a piggery 3

3: **PIGGERY WASTE: CHARACTERISTICS AND POTENTIAL ENVIRONMENTAL PROBLEMS**
- 3.1 General characteristics of piggery waste 5
- 3.2 Potential impacts of piggeries on the environment 6
- 3.3 Potential impacts on operators and animal health 7

4: **SITE SELECTION**
- 4.1 Site selection factors 9
- 4.2 Sites not suitable for piggeries 12

5: **ENVIRONMENTAL MANAGEMENT OF INTENSIVE PIGGERIES**
- 5.1 Effluent management 13
- 5.2 Effluent treatment 13
- 5.3 Treated effluent reuse and disposal 16
- 6.1 Straw based housing systems 19

6: **ENVIRONMENTAL MANAGEMENT OF STRAW BASED HOUSING SYSTEMS**
- 6.2 Utilisation of straw waste 19

7: **ENVIRONMENTAL MANAGEMENT OF EXTENSIVE PIGGERIES**
- 7.1 Characteristics of extensive production 21
- 7.2 Stocking densities 21
- 7.3 Pen rotation 22
- 7.4 General land management issues 24

8: **OTHER WASTE MANAGEMENT ISSUES**
- 8.1 Solid waste storage, use and disposal 25
- 8.2 Carcass disposal 26
- 8.3 Use and disposal of agricultural and veterinary chemicals 26

9: **ENVIRONMENTAL MANAGEMENT PLANS**
- 9.1 Requirements of environmental management plans 29
- 9.2 Contingency plans 29
- 9.3 Monitoring 29
- 9.4 Reporting 30

10: **REFERENCES** 31

APPENDIX 1: **GLOSSARY OF TERMS & ABBREVIATIONS** 33

APPENDIX 2: **LEGAL REQUIREMENTS** 35
- A2.1 Relevant Acts in Western Australia 35
- A2.2 Planning requirements 35
- A2.3 Environmental requirements 35
- A2.4 Requirements of the Health Act 1911 37
- A2.5 Other Requirements 37

APPENDIX 3: **USEFUL CONTACTS** 39

INDEX 41
1: INTRODUCTION

1.1 Scope of these Guidelines

These guidelines apply to the management of piggeries in Western Australia, including intensive and extensive operations, straw-based housing and combinations of these (otherwise referred to as semi-intensive housing).

1.2 Background to the pork industry in Western Australia

For many years the raising of pigs has been a useful part of mixed farming operations, particularly in the wheatbelt areas of Western Australia where they can be extensively raised and fed on cheap grain. Intensive piggeries have become part of an increasingly specialised industry for raising large numbers of pigs in a small area with the use of highly technical methods, including precise nutrition. The changes within the industry have led to a concentration of large quantities of animal wastes (EPA, 1991).

A number of useful products are derived from the pig industry. The meat of pigs can be used to produce bacon, ham, smallgoods such as salamis and sausages, and many different cuts of pork which are closely comparable to the cuts obtained from beef cattle. Their skin, hair, fat and hooves are used to make leather, glue, soap, brushes, lard, fertiliser, medicines and other products (EPA, 1991).

In 1999 exports of pork products to Asia increased dramatically.

1.3 Intensive pork production in Western Australia

Growing pigs under intensive conditions where the animals spend their entire life cycle indoors, is an important part of the Western Australian and Australian agricultural economies.

In 1997-98, Australia slaughtered about 4.86 million pigs. Of these about 550,000 or 11 per cent came from Western Australia.

In the same period, the total carcase weight of Australian production was 325,590 tonnes of pig meat worth about $880 million. In Western Australia in 1997-98, there were about 600 registered pig growing establishments which produced pig carcases worth about $87.5 million (35,500 tonnes). Of these establishments, about 75 had a pig herd of more than 1,000 animals including suckers, weaners, growers etc. The average herd size of 80 sows (around 800 pigs) is large by international standards, which means that new technology is likely to be adopted quicker and more effectively (Australian Bureau of Statistics - Pigstats98).

Most of the pig products are consumed by the domestic market, but the industry with the assistance of Agwest Trade and Development is attempting to facilitate the industry becoming a competitive supplier of pork products on the world market.

Intensive piggeries produce considerable quantities of concentrated waste and therefore have the potential to adversely affect the environment if not adequately managed.
1.4 Extensive pork production in Western Australia

Australia is now part of the international market for pork products and the need to produce a quality product at least cost is essential for the industry to survive.

To facilitate the expansion of the industry to achieve economies of size and scale, it is important to minimise the capital cost involved in pig housing. In extensive piggeries, the pigs are essentially free range at stocking densities which will, if well managed, not lead to irreversible land degradation.

Expansion of the pig industry in WA to meet new Asian markets needs to be cost competitive, therefore part of the industry is looking to “lower cost” extensive piggeries.

Much of the lower Great Southern area of WA is considered a good location for extensive pig production, as the climate is suitably mild and grain is plentiful.

Industry estimates that there are in excess of 6,000 sows in the lower Great Southern producing up to 100,000 pigs each year, worth $20 million per annum to the State.

1.5 Alternative straw based housing

The cost of new conventional intensive housing for grower/finisher pigs has increased disproportionately to returns in recent years and the adoption of “all-in all-out” (AIAO) management practices can further add to this cost (Payne 1995).

Low cost, welfare-friendly, alternative housing systems for grower/finisher pigs have been developed overseas, using unconventional, inexpensive building materials. A number of these systems use tunnel housing comprised of tubular steel framing with a synthetic cover, side barriers, and sawdust or straw bedding. Research at Agriculture Western Australia's Medina Research Centre has demonstrated that these systems are well suited to West Australian conditions (Payne 1995).

Several producers have made major commitments to production using these systems. Agriculture Western Australia has further evaluated these systems for housing breeding animals. There are at least five proprietary low-cost housing systems available in Western Australia. Further information on these systems is available from Agriculture Western Australia.
## Legal Requirements

### 2.1 Approvals required to establish and/or operate a piggery

The following figures, Figures 1A and 1B, provide a summary of the approval processes required to establish and operate a piggery in Western Australia.

Discussion of legislation relevant to the establishment and/or operation of a piggery is provided in Appendix 2.

**Figure 1A: Approvals required prior to construction and/or upgrade of a piggery.**

<table>
<thead>
<tr>
<th>Approval Required</th>
<th>Comments</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Planning approval</td>
<td>Offensive trade consent and registration only required where the premises is within a prescribed area.</td>
<td>Local Government</td>
</tr>
<tr>
<td>2. Building approval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Offensive Trade consent &amp; registration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Works approval *</td>
<td>Only applies to intensive piggeries of 500 pigs or more</td>
<td>Department of Environmental Protection</td>
</tr>
<tr>
<td>5. Groundwater well licence</td>
<td>Required if located in a Proclaimed Groundwater Area or if drawing from a confined aquifer (i.e., artesian supply), which is the case for the majority of the State. This is particularly important to consider with respect to whether you will have adequate water supply to establish/operate a piggery at that site.</td>
<td>Water and Rivers Commission</td>
</tr>
<tr>
<td>6. Surface water licence</td>
<td>Required if surface water is to be used in a Proclaimed Surface Water Area</td>
<td>Water and Rivers Commission</td>
</tr>
<tr>
<td>7. Advice regarding suitability of site</td>
<td>Piggeries are not permitted in Public Drinking Water Source Areas. Contact your local office for more information.</td>
<td>Water and Rivers Commission</td>
</tr>
</tbody>
</table>

* Approvals 2, 4, 5, 6 can be sought concurrently if they are required.

* Any piggery proposal may also be referred to the Environmental Protection Authority (EPA) for formal assessment if there are significant environmental issues associated with the proposed location and/or nature of operations.

**Figure 1B: Approvals required for the ongoing operation of new or existing piggeries.**

<table>
<thead>
<tr>
<th>Approval Required</th>
<th>Comments</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Offensive trade registration</td>
<td>Only applies where the premises is within a prescribed area.</td>
<td>Local government</td>
</tr>
<tr>
<td>2. Licence</td>
<td>Only applies to intensive piggeries of 1000 animals or more.</td>
<td>Department of Environmental Protection</td>
</tr>
<tr>
<td>3. Registration</td>
<td>Only applies to intensive piggeries of 500 pigs or less.</td>
<td>Department of Environmental Protection</td>
</tr>
<tr>
<td>4. Groundwater well licence</td>
<td>Comments as for Prior to Construction - Figure 1A</td>
<td>Water and Rivers Commission</td>
</tr>
<tr>
<td>5. Surface water licence</td>
<td>Comments as for Prior to Construction - Figure 1A</td>
<td>Water and Rivers Commission</td>
</tr>
</tbody>
</table>
3: PIGGERY WASTE: CHARACTERISTICS AND POTENTIAL ENVIRONMENTAL PROBLEMS

3.1 General characteristics of piggery waste

A pig typically voids about 6 per cent of its body weight every day (Kruger et al., 1995). In intensive piggeries, this waste is commonly mixed with flushing water in the sheds and discharged as a slurry. Piggery effluent typically contains large amounts of nitrogen compounds and phosphorus derived from urine and faeces. In addition piggery effluent contains salts, volatile organics, suspended solids and possibly agricultural or veterinary chemicals (Kruger et al., 1995).

Typically, the nitrogen derived from urine is mostly in the form of urea. Ammonification and hydrolysis into ammonia and ammonium salts alter this and other organic forms of nitrogen by the action of microbes and enzymes respectively. The products are pH dependent with ammonium carbonate and other salts forming under acid to neutral conditions and free ammonia predominant where pH is in the range 9 to 10. Nitrogen compounds in faeces are usually a mixture of ammonium ions, free amino acids, undigested proteins from the feed and bacterial proteins (Payne, 1990a).

3.1.1 Chemical and physical composition

The typical composition of piggery waste is given in Table 1. More comprehensive and detailed data are available in Kruger et al. (1995) (Reference 20, Chapter 3).

Other factors (Kruger et al., 1995) which may influence the values shown in Table 1 include:

- composition of diets;
- variation from “average” water usage;
- piggery type (intensive/extension or straw-based); and
- type of operation (farrow to finish, grow-out or breeder unit).

Piggery waste can contain:

- waste feed;
- residues of disinfectants and detergents;
- water from both drinkers and leaks in the supply system;
- bedding material if used;
- water used for washing down and flushing;
- placental material;
- dead pigs; and
- syringes, bottles, paper, plastics and various containers.

The chemicals found in piggery waste include manganese, iron, calcium, zinc, sodium, selenium, magnesium and chloride ions, and various elements in trace quantities that may be useful for other purposes.

3.1.2 Microbiological characteristics

All animals expel microorganisms with faecal matter. These may include pathogens such as Salmonella species, which can survive for a considerable time outside the host animal. Waste treatment systems, when operating efficiently, remove most bacteria, but viruses, protozoa and parasites are more resilient and may remain viable, at high levels for long periods (Ryan and Payne, 1989).

Table 1: Daily excreta production for a 45kg pig and annual production for a 1,000 pig herd *

<table>
<thead>
<tr>
<th>Component</th>
<th>Per pig per day (grams)</th>
<th>Per cent dry manure</th>
<th>Tonnes/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Manure</td>
<td>4700</td>
<td></td>
<td>1700</td>
</tr>
<tr>
<td>Dry Manure</td>
<td>300</td>
<td>100</td>
<td>110</td>
</tr>
<tr>
<td>Volatile Solids</td>
<td>250</td>
<td>85</td>
<td>90</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>190</td>
<td>65</td>
<td>70</td>
</tr>
<tr>
<td>BOD5 *</td>
<td>150</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>20</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>8.0</td>
<td>2.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Potassium</td>
<td>5.0</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Sodium</td>
<td>1.5</td>
<td>0.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*BOD 5 = Five day biochemical oxygen demand

* This table gives typical waste loads for a 45kg pig (approx average weight of animals in a breeder/grower herd). Material may be diluted in up to 60 litres of water/pig/day depending on waste treatment used and water loss from drinker leakage, and washdown water.

(Ryan & Payne, 1989)
3.2 Potential impacts of piggeries on the environment

Piggery waste contains large quantities of nitrogen and phosphorus compounds and other salts. Poorly managed piggeries can lead to degradation of water resources resulting in the sources being unsuitable for their beneficial uses. Another potential problem, specific to extensive piggeries, is soil degradation which can result in loss of topsoil and difficulty re-establishing vegetation.

3.2.1 Potential impacts on water resources

- Build up of nitrogen and phosphorus compounds in surface waters that encourage algal growth, can cause:
  - changes in taste, odour, colour and visual appeal;
  - ecosystem alteration (eg smothering of aquatic plants); and
  - toxicity problems with the water.
- Increase in biochemical oxygen demand from the decay of organic matter leading to offensive odours and the death of aquatic animals by asphyxiation.
- Nitrate contamination of groundwater which may reach levels toxic to humans (especially infants), livestock, native plants and native animals.
- Build up of salts in groundwater above acceptable levels for irrigation of vegetation or release into fresh water resources.
- Possibility of the spread of parasites and other disease organisms in either surface or groundwater.

(Ryan and Payne, 1989).

3.2.2 Potential impacts on land

Some soils are not suitable for extensive piggeries and, even on suitable soils, poor management practices can lead to deterioration.

- Surface compaction may lead to greater run-off, turbidity of streams and an increased loss of nutrients to waterways. Under these circumstances, especially during the drier months, windblown dust is likely to be a nuisance to neighbours and result in a long-term soil fertility decline.
- Unprotected trees may be ringbarked by pigs.
- Excessive stocking rates will accelerate the degradation of the land.
- Pigs escaped from an extensive piggery may cause environmental damage to national parks, forests and rangelands.

(Department of Environmental Protection, 1995).

3.2.3 Potential impacts on neighbours and the local community

Odour

Odour has traditionally been considered a major problem with piggeries. Odours are particularly noticeable where wastes are stored before treatment, shed cleaning is poor or where treatment systems become overloaded. Piggeries in close proximity to urban or other residential areas (especially upwind) should take preventative measures to minimise potential odour impacts and complaints.

Visual impact

Keeping sheds and surrounding areas unobtrusive and tidy, or screened by hills and vegetation, will minimise complaints by providing some screening for noise and odour control.

Insects

Stored wet manure or poor hygiene standards can attract nuisance insects.

Biosecurity

Disease and parasite transmission onto or off the property by man, pigs or other animals should be avoided.

(Ryan and Payne, 1989).

Noise control

Unavoidable noise nuisance may result when pigs are moved or loaded at night or very early in the morning. Similar problems may occur during periods of high fire risk when restrictions on vehicle movements may require feed deliveries and feed distribution to be carried out during the night.

Noise levels from the piggery operations should be in accordance with the Environmental Protection (Noise) Regulations 1997. Further advice regarding appropriate noise levels should initially be sought from the relevant local government authority.

Lighting

Lights used to illuminate any areas of the site for security or any other reason should be angled or shaded so that the light does not directly illuminate any nearby residential premises.

(Department of Environmental Protection, 1995).
3.3 Potential impacts on operators and animal health

Piggery operators should be aware of the requirements of the Occupational Health, Safety and Welfare legislation which requires that an employer shall, as far as practicable, provide and maintain a working environment in which employees are not exposed to hazards.

Piggery gases can harm both humans and animals and may also pose explosion hazards when allowed to accumulate. Carbon dioxide, methane, ammonia and hydrogen sulphide gases are produced wherever manure is stored. The worst sites are within slurry tanks, drains and areas having little ventilation.

Outside of sheds, waste treatment areas should be considered as a potential source of disease-causing organisms and treated accordingly. In particular, animals should be denied access to such areas to minimise potential spread of disease.

Other areas of potential hazard to operators and/or animals include:

- manual stock handling (need to minimise risk of injury to workers, eg through supervision of inexperienced workers);
- manure handling (potential for spread of disease);
- potential for allergic and respiratory reactions caused by dusty materials;
- use of agricultural and veterinary chemicals. It is recommended that all personnel using such products have completed appropriate training such as the ‘Do it Right’ and the ‘ChemCert’ Farm Chemical Users training courses; and
- use of farmyard machinery, such as tractors and front-end loaders.
4: SITE SELECTION

4.1 Site selection factors

In order to minimise the impact of the piggery on the environment, the piggery and infrastructure should have:

- appropriate siting; and
- provision for the treatment and disposal of wastes.

This chapter focuses on appropriate siting, while waste treatment and disposal are addressed in Chapters 5 and 8.

The main site selection factors to consider include:

- climate;
- proximity to environmentally sensitive areas;
- relationship to residential areas (such as built-up, semi-rural and special rural areas);
- water supply (suitability and availability);
- adequate land for necessary waste treatment and disposal;
- topography;
- soils; and
- vegetation.

4.1.1 Climate

Climate should be appropriate for the welfare of the pigs. Generally they do best in the southern areas of the State. The northern parts of the State are not as suitable for pig production because of the harsh climatic conditions and the disadvantages of distance from markets.

Rainfall or groundwater resources should be adequate to supply water to fill storage dams that provide drinking and, where relevant, wash-down water in the piggery. Evaporation rates should be such that any ponding systems used to store treated effluent can adequately cope with effluent over the whole year without the risk of uncontrolled overflow into the local environment.

4.1.2 Proximity to environmentally sensitive areas

Piggeries and associated facilities should be sited away from residential and environmentally sensitive areas such as public drinking water source areas, waterways and wetlands. Very stringent waste control and treatment facilities are required in areas such as the Darling Scarp and the Swan Coastal Plain.

Piggeries are not acceptable in Public Drinking Water Source Areas. The Water and Rivers Commission should be contacted for the location of such areas (refer to Appendix 3 for contact numbers).
Table 2: Recommended separation distances ("buffers") for piggeries and associated facilities (distance in metres)

<table>
<thead>
<tr>
<th>Townsite Boundaries</th>
<th>Special rural areas †</th>
<th>Isolated rural dwellings, dairies, industries</th>
<th>Public Roads</th>
<th>Neighbouring rural property boundaries</th>
<th>Public Drinking Water Source Areas ††</th>
<th>Major watercourses &amp; rural water impoundments</th>
<th>Bores, wells, soaks for private drinking water supply</th>
<th>Bores, wells, soaks for stock irrigation supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive piggeries †††</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 5000 pigs</td>
<td>5000</td>
<td>2000</td>
<td>300</td>
<td>200</td>
<td>50</td>
<td>not permitted</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>500 - 5000 pigs</td>
<td>3500</td>
<td>1500</td>
<td>300</td>
<td>150</td>
<td>50</td>
<td>not permitted</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>50 -500 pigs</td>
<td>2000</td>
<td>1000</td>
<td>300</td>
<td>100</td>
<td>50</td>
<td>not permitted</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Less than 50 pigs</td>
<td>500</td>
<td>500</td>
<td>300</td>
<td>50</td>
<td>30</td>
<td>not permitted</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Extensive piggeries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All extensive piggeries</td>
<td>1000</td>
<td>1000</td>
<td>300</td>
<td>50</td>
<td>50</td>
<td>not permitted</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>All piggeries - waste reuse / disposal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land used to dispose of raw or partly treated wastes</td>
<td>1000</td>
<td>1000</td>
<td>300</td>
<td>100</td>
<td>50</td>
<td>not permitted</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Land used to contain, treat or dispose of treated wastes ††††</td>
<td>200</td>
<td>100</td>
<td>50</td>
<td>20</td>
<td>20</td>
<td>not permitted</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Adapted from Ryan and Payne, 1989 and Department of Environmental Protection, 1995.

† Recommended buffers for special rural areas have been extrapolated from Ryan & Payne (1989)

†† Refer to section A2.3.2 of Appendix 2 for more information on Public Drinking Water Source Areas

††† Number of pigs refers to all animals post weaning (e.g. post three to four weeks of age)

†††† Separation distance based on appropriate containment/treatment/disposal option selected for the site. The requirements of the State Industrial Buffer Policy, which requires a buffer of 1000m, will be applicable if more than 1000 tonnes of material that is to be composted is produced per annum.
4.1.3 Seperation distances to residential areas

The piggery should be sited, designed, constructed and operated to prevent unreasonable interference with the health, welfare, convenience, comfort or amenity of any person. Factors to be considered are:

- human health;
- visual appearance;
- odour;
- dust;
- flies; and
- noise from both the facility and transport requirements

For new piggeries, a buffer zone based on scientific evidence should be established to protect both the community from the effects of future piggery development and the piggery from the contraints of future commercial or residential development (Streeten, 1997).

Recommended minimum buffer distances (ie separation distances) between the perimeter of piggery buildings, waste treatment and disposal areas and various features which may be affected, are provided in Table 2.

4.1.4 Water supply (suitability and availability)

Water supply for the piggery (drinking and other water needs) ideally should be from local groundwater and/or storage dams. The use of mains water is usually relatively expensive and may already be allocated. Until there are adequate or suitable water supplies, it may not be feasible to operate at a particular site.

Factors to consider in determining water supply availability and suitability include:

- water usage requirements, e.g. for
  - drinking;
  - flushing; and
  - general housekeeping.
- licensing requirements of the Water and Rivers Commission (refer to Chapter 2);
- water availability - if there is no water available, additional sources such as mains water may be required (contact Water and Rivers Commission, refer to Appendix 3); and
- suitability of the water for the desired use.

Water usage in piggeries is highly variable and there is little data on overall usage. Piggeries requiring water for flushing sheds (ie intensive operations) use in the order of 20 to 40 litres of flushing water per pig per day.

Figures given in Table 3 are from a Western Australian survey of water usage conducted in 1987.

### Table 3: Daily summer and winter drinking requirements for pigs

<table>
<thead>
<tr>
<th>Type of Animal</th>
<th>Litres/pig/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
</tr>
<tr>
<td>Boar, dry sow or gilt</td>
<td>39</td>
</tr>
<tr>
<td>Lactating sow</td>
<td>80</td>
</tr>
<tr>
<td>Weaner</td>
<td>9</td>
</tr>
<tr>
<td>Grower</td>
<td>13</td>
</tr>
<tr>
<td>Overall Average</td>
<td>16</td>
</tr>
</tbody>
</table>

(Ryan and Payne, 1989)

### Table 4: Suggested water allowances for Western Australian piggeries

<table>
<thead>
<tr>
<th>Use</th>
<th>Litres/pig/day</th>
<th>kL / 100 sows/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td>17</td>
<td>6,200</td>
</tr>
<tr>
<td>Washing</td>
<td>5</td>
<td>1,800</td>
</tr>
<tr>
<td>Flushing (if used)</td>
<td>20</td>
<td>7,300</td>
</tr>
<tr>
<td>Total - without flushing</td>
<td>22</td>
<td>8,000</td>
</tr>
<tr>
<td>- with flushing</td>
<td>42</td>
<td>15,300</td>
</tr>
</tbody>
</table>

(Ryan and Payne, 1989)

An important factor to consider in water quality is salinity. Pigs are reasonably tolerant to saline drinking waters. The recommended short term upper safe limit (Agriculture Western Australia) is 4,500 mg/L below of total dissolved solids (TDS) or 3000 mg/L for continuing use. Lower salt levels should be sought as this will allow for seasonal fluctuations or long-term increases in salinity levels (Ryan and Payne, 1989).

4.1.5 Adequate land for waste treatment and disposal

The selection of an appropriate waste management system should be based on environmental impact, particularly with respect to how wastes will be disposed of, operating costs, initial investment, upkeep and labour costs. The site selection process should consider the land requirements necessary for the desired waste management system. This may include provision for treatment ponds and waste storage areas.
4.1.6 Topography
The site should be well drained, level or gently sloping (preferably between one in 20 and one in 200), to minimise sheet flow of stormwater without the risk of water-logging, ponding after heavy rains or excessive run-off. This is particularly important for extensive piggeries.

Consideration should be given to a site which does not readily allow surface water to cause erosion or to gain ready access to drains and watercourses. Sandy soils may be unsuitable in this instance.

Flood prone sites should be avoided since they provide a high risk of washing nutrients into local water courses, and the added risk of destroying or damaging buildings and stock.

4.1.7 Soils
Soils should preferably be loams rich in iron and aluminium oxides, thereby providing a barrier to the leaching of nutrients into the sub-soil and groundwater. Sandy soils are generally unsuitable because they can leach nutrients.

The gravelly ironstone or laterite loams and loamy clays, that are common throughout the south-west and wheatbelt and associated 'breakaway' country, are examples of soils high in iron and aluminium.

Soil structure should preferably be firm, for example sandy loam or gravel, so that vehicles can be used on it all year round. This type of soil generally has a moderate (>1cm/hour) infiltration rate sufficient to preclude surface ponding of effluent and run-off of rain.

Heavy clay soils should be avoided and loose sands are particularly unsuitable for extensive piggeries. Advice should be sought from a person having suitable expertise in soil types and conservation before selecting the site, particularly for extensive piggeries.

Environmental management for all piggeries will be made simpler if the soil is of a type that has a reasonable ability to retain phosphorus.

The phosphorus retention index (PRI) is a measure of the soil's ability to retain phosphate.

Sandy loams, loams and clay loams, contain greater amounts of iron and aluminium, and therefore have greater PRIs. It is recommended that the soil where the piggery is to be established is tested to determine the PRI of the soils. Preferably the PRI should be greater than 10.

Continued phosphorus applications, even to high PRI soils, will eventually lead to phosphorus loss when the soil becomes saturated with phosphorus.

4.1.8 Vegetation
A good vegetation cover (e.g. pasture or stubble) is important for areas used to raise pigs extensively, as well as in buffer areas within the property. Where nitrogen and phosphorus application to land is to be part of the waste management system, vegetation with high nitrogen requirements should be considered.

Extensive pig enclosures should be located on cleared land with either pasture or stubble providing adequate ground cover. Land with grasses that will survive on little rain, are the most suitable as they will trap manure and enhance infiltration from first rains.

In addition, shade trees provide protection for the pigs from the sun. A suitable area will have plentiful trees outside of the enclosures. Pens should not contain unprotected remnant native vegetation (Department of Environmental Protection, 1995).

4.2 Sites unsuitable for piggeries
Based on the factors discussed in section 4.1 above, piggeries should not be located where the following conditions exist:

- site is located within a Public Drinking Water Source Area;
- shallow depth to water table (ie less than 1.5 metres below the surface throughout the year);
- land with a gradient greater than 1 in 10 for intensive piggeries or greater than 1 in 20 for extensive piggeries;
- sandy coastal soils with low PRI;
- heavy soils with low water permeability (e.g. peat, clay or silt);
- within buffer zones and/or catchment areas for wetlands, permanent water courses, drains or other waterbodies;
- within buffer zones for public recreation areas and roads;
- land subject to flooding; and
- small parcels of land where effective perimeter buffers cannot be established

(Ryan and Payne, 1989).
5: ENVIRONMENTAL MANAGEMENT OF INTENSIVE PIGGERIES

5.1 Effluent management
Where animals are to be reared in more traditional shedding arrangements, flushing of wastes from the shed will be required. The only material that should enter the effluent stream from outside the pig shed is water from washing down stock transport. Human sewage, roof and yard drainage, and carcasses of dead pigs should not enter the waste disposal system.

Intensive operations can generate large volumes of effluent that will require treatment and disposal. Best practice is to recycle water from the last stage of the effluent treatment process for washdown. However, this may cause problems due to a build up of struvite (see 5.3.2).

‘Pull plug recharge’ based effluent systems have enabled major reductions in water usage and have diminished the levels of odour production.

The objectives of treating effluent from intensive piggeries are to reduce effluent handling problems, odour and prevent spread of disease (off-site or by reintroduction to sheds). Where land application is being considered, some form of prior treatment is usually required. In this case an additional objective of effluent treatment is to reduce nutrient loading, especially nitrogen and phosphorus.

Various combinations of the following treatments can meet these objectives:

- solids removal;
- stabilisation and removal of dissolved organic matter, such as proteins and possible traces of veterinary chemicals and pesticides.
- destruction of pathogenic bacteria, viruses and parasites;
- removal of nutrients, especially nitrogen and phosphorus; and
- removal of toxic substances such as heavy metals (Kruger et al., 1995).

The technique chosen will depend on the size of the piggery, its location, environmental constraints and the degree of sophistication that management is prepared to fund and operate.

Like any other agricultural venture, an intensive piggery will generate stormwater from its roofs and paved areas. This comparatively clean water can be collected and used as drinking, cooling or flushing water for the piggery. Stormwater should not be immediately directed into the effluent treatment stream as this will considerably increase the volume of waste to be treated.

Ideally, tanks or ponds will be used to store stormwater for later use and have sufficient capacity to handle an exceptionally wet period. To this end, a one in ten year, 72 hour, rainfall or storm event should be factored into the design of such storage systems. For further information regarding effluent management options and some practical design methods, refer to Kruger et al. (1995) (Chapters 4, 5 and 7).

5.2 Effluent treatment

5.2.1 Solids separation
Solids removal should be undertaken, as it:

- increases the capacity of effluent treatment systems;
- avoids blockages in plumbing;
- decreases sludge build up in ponds; and
- aids the separation of slowly degrading particulate matter from quickly degrading dissolved and colloidal matter.

Solids can be removed by:

- simple screening - a cheap and effective technique where effluent is passed over a screen to remove coarse solid material;
- settling - effective but is relatively complex and produces a difficult to handle sludge; or
- centrifuging and/or pressing - generally avoided due to the high capital and operating expense for the equipment.

Where a solids screen is used, it should be located on a hardstand area which is bunded and drained such that any run-off is directed back into the effluent treatment system. Refer to Chapter 8 for more detail on solids management and disposal.

5.2.2 Chemical treatment

Chemical agents can aid the flocculation of fine particles remaining after the effluent is screened. Calcium in the form of ordinary fine agricultural lime is particularly useful as a cheap flocculant. Addition of lime also helps to remove phosphorus from the effluent. Commercial polymers may be mixed with lime to aid flocculation and precipitation of the material. For small scale ventures, the addition of such compounds is less desirable due to the extra cost of the materials and the system required to deliver and monitor the chemical stream.

The further use and/or disposal of chemically stabilised sludge needs to be considered as part of the overall treatment process. Chapter 8 deals with general sludge handling and disposal issues.
Stabilisation ponds or lagoons are usually a combination of engineered ponds where effluent is run into an interconnected ponding system. Ponds replicate the cleansing characteristics of natural aquatic ecosystems. Organic matter is consumed by microorganisms in the water and changed into very simple compounds such as carbon dioxide, nitrogen and methane. Well designed and managed pond systems produce an odourless sludge and a stable effluent.

Using several linked ponds can give a progression from anaerobic through to aerobic conditions and allow very good breakdown of the waste.

Ponds require large areas of land, low permeability soils or liners. They do not remove phosphorus, heavy metals or other non-gaseous substances. These materials accumulate in the sludge layer at the bottom of the pond from where they may end up being recycled back through water reused from the ponds. (Kruger et al., 1995).

Descriptions of the types of ponds used in intensive piggeries follow. A comparison of the advantages and disadvantages of these ponds and basic design criteria are provided in Tables 5 and 6, respectively.

**Table 5: Comparison of types of stabilisation ponds**

<table>
<thead>
<tr>
<th>Pond Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anaerobic</strong></td>
<td>• simple to design and operate&lt;br&gt;• relatively cheap to construct&lt;br&gt;• can treat concentrated effluent and cope with wide variations in effluent quality&lt;br&gt;• long storage time (about 7 to 20 days) allows flexibility of operation and treated effluent to be re-used</td>
<td>• decomposition process prone to temperature variation with season which can limit pond loading rate and affect bacterial activity, with resultant odour problems (ponds work best in climates without cold winters)&lt;br&gt;• pond mainly works as a storage and settling facility during winter with low bacterial activity&lt;br&gt;• activity of bacteria is greater at warm temperatures, eg. 30 to 40°C, however enzymes function poorly and growth is inhibited in very hot weather&lt;br&gt;• accumulation of salts and sludge may cause handling problems&lt;br&gt;• significant loss of nutrients may contaminate groundwater if not properly lined</td>
</tr>
<tr>
<td><strong>Facultative</strong></td>
<td>• provides further stabilisation and pathogenic destruction of effluent prior to reuse</td>
<td>• leaching and loss of nutrients may contaminate groundwater if not properly lined</td>
</tr>
<tr>
<td>(a mix of Anaerobic and Aerobic strata)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Aerobic / Evaporative</strong></td>
<td>• assists in disposal of effluent by evaporation (particularly where annual evaporation clearly exceeds annual rainfall)&lt;br&gt;• useful low-cost alternative where no other reuse or disposal option is available and/or environmentally acceptable&lt;br&gt;• designs are based on microbial respiration requirements for oxygen taken from the atmosphere</td>
<td>• if evaporation is only means of effluent disposal, can require large areas of land&lt;br&gt;• loss of nutrients with possible groundwater pollution if not properly lined&lt;br&gt;• solar evaporation can lead to build up of very high salinity&lt;br&gt;• levels which can be either toxic to pond bacteria and/or inhibit their growth&lt;br&gt;• highly saline effluent is unsuitable for land application&lt;br&gt;• treated effluent used for irrigation may require dilution with fresh water to prevent or slow any salinity build up</td>
</tr>
</tbody>
</table>

Based on: Kruger et al, 1995
Facultative pond / lagoon

This type of pond is aerobic near the surface and anaerobic at greater depths and is usually used as a second stage pond. Second stage ponds provide further treatment of effluent but usually not to the extent that the material can be reused or disposed of.

Aerobic / evaporation pond / lagoons

These ponds have bacteria which require an abundant supply of oxygen in the water and are therefore designed to be rich in oxygen. The oxygen in these ponds comes from the atmosphere by diffusion and algae in the water. Piggery effluent is usually too concentrated to allow for true oxygen rich conditions, with most ponds being either facultative or essentially an evaporation pond.

Pond liners

All effluent treatment ponds should have a low permeability (<10^-9 m/s) liner to prevent leakage into the sub surface soils and groundwater. Preferably a clay or synthetic liner, such as high density polyethylene (HDPE), should be used.

The Water and Rivers Commission has guidelines which recommend the minimum specifications for pond liners. These guidelines should be consulted before designing and constructing new ponds.

Table 6: Basic stabilisation pond design criteria

<table>
<thead>
<tr>
<th>Design Criteria</th>
<th>Anaerobic</th>
<th>Facultative</th>
<th>Aerobic / Evaporative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>&gt; 2.5 meters, desirably 4 metres or more</td>
<td>1.5 to 2.5 metres</td>
<td>a depth of 0.3 to 1.2 metres is required (to enable sunlight to adequately penetrate pond depth as oxygen producing algae require sunlight for growth)</td>
</tr>
<tr>
<td>Surface Area</td>
<td>relatively small</td>
<td>typically relatively large</td>
<td>relatively large (many hectares for a large establishment)</td>
</tr>
<tr>
<td>Loading Rate</td>
<td>• unscreened effluent: approximately 100g volatile solids/m2/day (based on capacity of 3m per pig place) ↑</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• screened effluent: ↑</td>
<td>• 60 to 90g volatile solids/m2/day of surface area</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• assuming effluent has already been treated by an anaerobic stage and may undergo further aerobic treatment before reuse</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• depends on wind, average daily temperature and sunlight hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• northern parts of WA: 20 to 30g volatile solids/m2/day of surface area</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• south west of WA: 10 to 20g volatile solids/m2/day of surface area</td>
<td></td>
</tr>
<tr>
<td>Storage Capacity</td>
<td>• combined pond system requires sufficient total capacity to store additional water generated by rainfall, particularly storm events, without overflowing of the ponds. ↑↑</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• able to retain a 10 year return frequency, 72 hour storm event, using a runoff coefficient of 0.8 for the piggery and associated works↑↑↑</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• able to contain all stormwater captured in pens in a 90 percentile wet year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Ryan and Payne, 1989 with modifications

↑ Refer to Effluent at Work pp 79 to 85

↑↑ Data regarding rainfall and evaporation rates for locations in Western Australia is available from the Bureau of Meteorology (refer to Appendix 3)

↑↑↑ Refer to the Institution for Engineers of Australia Australian Rainfall and Runoff
5.2.4 Other treatment methods
There are many other ways that effluent can be treated. Following is a list of some such methods, some of which are discussed in more detail in some of the references listed in Chapter 10, such as Kruger et al, 1995 and Ryan and Payne, 1989:

- artificial aeration;
- activated sludge;
- rotating biological contactors;
- trickling filters;
- constructed wetlands;
- methane digesters; and
- biodigesters.

These systems are not discussed in detail here as they are mostly either:

- in the experimental stage;
- have not yet been proven for use in Western Australian piggeries;
- are better suited for less concentrated effluent than is produced by piggeries;
- are more suited to polishing low nutrient effluent; and/or
- often require large capital expenditure and/or running costs (eg require expert personnel for proper operation).

5.2.5 Disposal without prior treatment
For small ventures (ie less than 50 sows) located in areas with a low risk of water pollution where there are no feasible alternatives, it may be possible to apply untreated effluent directly onto the land (Payne, 1990b). However, this is not usually a recommended practice and the process would have to be acceptable to the appropriate authorities such as Department of Environmental Protection, Water and Rivers Commission and the relevant local government.

5.3 Treated effluent reuse and disposal
Effluent is often generated at a rate greater than it can be utilised. The effluent reuse and/or disposal system needs to make provision for the storage of effluent until the time it can be disposed of or utilised.

The main methods of treated effluent reuse and/or disposal are:

- evaporation ponds;
- recycling to shed (eg for flushing); and
- irrigation of vegetation.

5.3.1 Evaporation
Evaporation ponds, as described in section 5.2 above, may be used as a method of disposing of superfluous effluent from the final treatment pond and in some instances, due to environmental constraints, this may be the only suitable disposal option.

*Note: Evaporation rates decrease as the level of pond salinity levels increase.*

5.3.2 Recycling to sheds
This process is useful for the purpose of flushing out the effluent channels and is a sound use for treated effluent from the final stages of a ponding system.

Recycled effluent should not be used as drinking or cooling water for the pigs due to the probability of it containing disease pathogens and high levels of dissolved salts, unless it is treated to a potable standard.

If recycled effluent is used for flushing, consideration should be given to the likelihood of pipe or pump blockages due to the deposition of the mineral struvite, which can be time consuming and expensive to remedy.

Struvite problems are difficult to predict for any given site, but magnesium rich groundwater seems likely to exacerbate the potential for these salts to deposit in the pumps or pipes (Kruger et al., 1995). The use of an acid treatment can control struvite, however, the cost of this adds to overall production costs and is likely to cause corrosion of metal pipes or fittings. Before recycled effluent is used, advice should be obtained from an analytical laboratory to ascertain whether the water is suitable.

5.3.3 Irrigation of vegetation using treated effluent
Treated effluent typically contains nitrogen and phosphorus concentrations of up to 300 mg/L and 50 mg/L, respectively, and a total dissolved salts (TDS) concentration of greater than 1000 mg/L (Water and Rivers Commission, 1998).

Treated effluent may be used for crop irrigation for its nutrients and to reuse the water. Care must be taken to avoid overloading the irrigated land with more nutrients than the soil and vegetation can absorb. Vegetation can also be killed as a result of excess nutrients, which could lead to soil erosion. Under adverse weather and seasonal conditions nutrient laden water can move off the property and may cause problems with public amenity or neighbouring properties.
Salinity is also an important consideration. The typical salt concentration in treated effluent can cause damage to some soils and cause groundwater pollution if excessive application rates are used.

Odour problems can occur when irrigating with effluent.

Professional advice is available through various environmental and/or irrigation consultancies. Contacts are listed in Appendix 3. The Water and Rivers Commission has Guidelines covering the irrigation of treated effluent which should be considered when designing an effluent irrigation system.

5.3.4 Design criteria

The main factors to consider when designing and operating an environmentally acceptable effluent irrigation system are:

- soil properties;
- proximity to water resources;
- nutrient uptake by plants;
- appropriate effluent application criteria; and
- runoff and drainage management.

Soil properties

The nutrient adsorption processes in soil are influenced largely by the type and quantity of clay, the presence of organic material and hydrous oxides. Soil analysis should be performed and should incorporate the determination of aluminium (Al₂O₃) and iron oxides, and organic carbon content as these parameters have a significant influence on phosphorus adsorption.

The main factors that affect the capacity of a soil to uptake the effluent are:

- local meteorology (seasonal rainfall and evaporation regime);
- soil composition;
- infiltration rates;
- phosphorus retention index (PRI); and soil nutrient status.

The ideal site for effluent reuse would have sandy loam soils, be well drained with the watertable at least 1.5 m below the surface in the wet season, a harvested vegetation type capable of a large uptake of nutrients and a gently sloping topography.

Tables 7 and 8 provide typical soil infiltration rates and phosphorus retention ability for different soil types.

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>per cent Clay</th>
<th>Typical IR (mm/hr)</th>
<th>Normal Range of IR (mm/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>&lt;5</td>
<td>50</td>
<td>20-250</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>5-15</td>
<td>20</td>
<td>10-80</td>
</tr>
<tr>
<td>Loam</td>
<td>15-25</td>
<td>10</td>
<td>1-20</td>
</tr>
<tr>
<td>Clay Loam</td>
<td>25-40</td>
<td>8</td>
<td>2-15</td>
</tr>
<tr>
<td>Silty Clay</td>
<td>40-60</td>
<td>2</td>
<td>0.3-5</td>
</tr>
<tr>
<td>Clay</td>
<td>&gt;50</td>
<td>0.5</td>
<td>0.1-8</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Topsoil Texture Group</th>
<th>Nature of Soil</th>
<th>PRI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands</td>
<td>light grey siliceous sands</td>
<td>0-2</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>dark grey or pale yellow brown siliceous sands</td>
<td>2-10</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>red, brown or yellow siliceous or earthy sands</td>
<td>10-20</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>sands with ferruginous gravels</td>
<td>10-20</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>calcareous sands</td>
<td>10-20</td>
<td>Moderate</td>
</tr>
<tr>
<td>Sandy loam or loams</td>
<td></td>
<td>20-200</td>
<td>Moderately high</td>
</tr>
<tr>
<td>Clay loam or clays</td>
<td></td>
<td>&gt;100</td>
<td>High</td>
</tr>
</tbody>
</table>

Source: Agriculture WA, Land Resources Series No.1
Proximity to water resources
To protect the quality of water resources:

- the proposed irrigation area should adhere to
  the buffer distances recommended in Table 2;
  and

- the depth to the normal wet season watertable
  should be at least 1.5m. The presence of a
  high watertable can reduce the ability of soil
  to retain nutrients as it affects the distance
  over which the soil bacteria can react with the
  percolating nutrients.

Nutrient uptake by plants
Plants have been used extensively to uptake irrigated
effluent. Examples include:

- pastures, e.g. lucerne, rye grass
- horticultural crops, e.g. turf farms, vegetables;
  and
- trees, e.g. Eucalyptus globulus, Pinus
  radiata.

Table 9: Typical nutrient uptake by various
plants and crops (kg/ha/year)

<table>
<thead>
<tr>
<th>Crop</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clover</td>
<td>180</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Lucerne</td>
<td>300</td>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td>Rye Grass</td>
<td>250</td>
<td>70</td>
<td>300</td>
</tr>
<tr>
<td>Potatoes</td>
<td>230</td>
<td>20</td>
<td>280</td>
</tr>
<tr>
<td>Oats</td>
<td>60</td>
<td>50</td>
<td>130</td>
</tr>
<tr>
<td>Eucalypts</td>
<td>90</td>
<td>15</td>
<td>60</td>
</tr>
</tbody>
</table>


† N = nitrogen, P = phosphorus, K = potassium

Application Criteria
Table 10 provides the maximum phosphorus and
nitrogen loading criteria applicable to treated effluent
irrigation.

When applying wastewater to the land the following
considerations are important:

- wastewater should be applied evenly to the
  land;

- a drying out period should be allowed
  between successive applications, the Field
  Capacity of the soil should not be exceeded;

- wastewater nutrient applications should take
  into account soil nutrient status; and

- hydraulic loading should avoid leaching
  below the root zone. This can be be checked
  with moisture meters.

In addition to nutrient application rates, the
following criteria also apply:

- degradable organic matter loading rate should
  not exceed 30kg/hectare/day (expressed as
  biochemical oxygen demand (BOD) ) to avoid
  offensive odours, ie further treatment prior to
  irrigation is required where BOD
  concentrations exceed 150 mg/L; and

- heavy metals in effluents should not exceed
  criteria given in Table 5.1 in ANZECC
  Australian Water Quality Guidelines for
  Fresh and Marine Waters, 1992.

The types or irrigation system (eg flood, sprinkler,
trickle etc) should also be considered with respect to
the suitability for the local soil types, distribution of
effluents achieved and likelihood of blockages due
to solids content of effluent.

Runoff and drainage management
Where irrigated land is not liable to absorb all of the
nutrients safely, a channel or drain installed on or
near the bottom or boundary of any sloping land is
highly recommended. The collected water should be
captured (eg returned to the final pond) and recycled
during a drier period of the year.

Table 10 - A guide to maximum phosphorus and nitrogen loading criteria

<table>
<thead>
<tr>
<th>Vulnerability category</th>
<th>Soil Description</th>
<th>Max Phosphorus (as P) loading (kg/ha/yr)</th>
<th>Max Nitrogen (as N) loading (kg/ha/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Coarse sandy soils / gravels draining to surface waters with mod/high eutrophication risk.</td>
<td>10</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>Coarse sandy soils / gravels draining to waters with a low risk of eutrophication.</td>
<td>20</td>
<td>180</td>
</tr>
<tr>
<td>C</td>
<td>Loams / clay soils (PRI&gt;10)*draining to waters with mod/high eutrophication risk.</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Loams / clay soils (PRI&gt;10)*draining to waters with a low risk of eutrophication.</td>
<td>120</td>
<td>480</td>
</tr>
</tbody>
</table>


* The Water and Rivers Commission should be consulted for more specific loading level information

* PRI = phosphorus retention index
6: ENVIRONMENTAL MANAGEMENT OF DEEP LITTER HOUSING SYSTEMS

6.1 Deep litter housing systems

Deep litter housing minimises the generation of effluent. It is not necessary to flush these facilities, therefore water usage is reduced and consequently there is a minimal effluent stream to manage.

Typically a shelter is a series of hooped, water proof, fabric-covered frames to form a shelter often 22 metres long and 9 metres wide. Such a facility can house various numbers of sows, weaners, growers, or finishers. A maximum stocking rate of about one square metre of floor space per finisher is recommended. Stocking rates usually provide the animals with much more space than traditional sheds, which may have implications for animal welfare.

Straw is placed over the floor to a depth that suits the number and size of the animals and the season. Barley straw is the type of straw preferred in the Western Australian pig industry as it absorbs urine and binds faeces more efficiently than other straws and its bedding characteristics (eg softness) are superior.

The floor can be earth, crushed limestone, stabilised soil or a concrete pad. A sealed floor provides for easier removal of the manure/straw pack.

6.2 Utilisation of straw waste

The faeces and urine, combined with the straw bedding, produces a material suitable for composting. After composting the material can be used on-farm or sold off-farm, especially for use in commercial horticulture and domestic gardens. If the material is composted and used appropriately, environmental impacts resources should be minimised.

If more than 1000 tonnes of compostable material is produced per year a 1000m buffer zone is required around the storage or processing facility (see table 2 and section 8.1.2 in chapter 8).

For further information on solid waste management in general, refer to Chapter 8.
Ecoshelter™ (left) and Clearspan™ (right) based housing systems are common across Western Australia.

A deep litter housing facility on the Swan Coastal plain.
7: Environmental Management of Extensive Piggeries

7.1 Characteristics of extensive production

Extensive piggeries are characterised by all or parts of the herd being housed in groups in enclosures, without the need for complex and expensive buildings. Pig-proof fencing is essential and in many cases the animals are confined within their enclosures by electric fencing.

Pregnant sows, those awaiting mating, and boars are provided with simple communal shelters. For farrowing, each sow is provided with her own shelter or hut, which has a deep bed of straw. After weaning there are several options for rearing the weaner pigs. They may be transferred to a conventional intensive rearing shed for all or part of their growth phase. Straw based shelters can also be used. Alternatively, they may be reared outdoors using some combination of simple pens for early weaned pigs and/or large paddocks for the later stages of growth.

As with all animal production activities, care needs to be taken to prevent irreversible land degradation and pollution of the environment. In an extensive piggery this is primarily achieved by:

- appropriate stocking densities;
- regular pen rotation; and
- good land management practices.

7.2 Stocking densities

It is essential to ensure that stocking density does not exceed the capacity of the land. Stocking densities may vary with location but should not exceed the densities specified in Table 11 below:

Table 11: Recommended maximum stocking densities

<table>
<thead>
<tr>
<th>Animals per hectare</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows &amp; boars</td>
<td>20</td>
</tr>
<tr>
<td>Sows (with litters)*</td>
<td>20</td>
</tr>
<tr>
<td>Growers &amp; finishers</td>
<td>50</td>
</tr>
<tr>
<td>Weaners **</td>
<td>**</td>
</tr>
</tbody>
</table>

* "litters" refers to unweaned piglets and it is considered that negligible effluent is generated by unweaned piglets.

** Refer to section 7.3 regarding weaner management.

On some soils a stocking rate of 20 adult pigs per hectare may be too high, hence the rate should be reduced as soon as possible to a level that does not cause excessive land or vegetation degradation.
7.3 Pen rotation

Systematically resting the land, by leaving paddocks vacant and by progressively moving pigs to new or rested sites, is vital for the prevention of land degradation and pollution problems. The areas that previously held pigs can then be cropped or rejuvenated by establishing pasture.

The piggery layout may consist of a series of paddocks joined by access tracks or roadways, or a "radial" system in which the enclosures radiate out from a central hub. An example of a "radial system" is shown in Figure 2.

Pigs should be moved to a fresh site of regrown pasture, whenever the ground shows signs of stress or vegetation cover is less than that deemed reasonable. Assessments of such impacts should be made in accordance with Agriculture Western Australia's Soil Interpretation Manual — Guidelines for interpreting agricultural soils in Western Australia (Moore and Scholz, 1994).

"Reasonable ground cover" is that which prevents wind or water erosion removing large quantities of soil from the immediate vicinity. This does not infer that every portion of land be vegetated, but that where un-vegetated areas do exist, they are balanced by sufficient cover within the immediate vicinity to prevent soil movement out of that area.

During the fallow period the land should be maintained in a stable condition.

Figure 2: Example radial layout for 240 sows and weaner accommodation
7.3.1 Weaner management

Traditionally weaners were reared in groups of about 200 in small paddocks. During recent years alternative weaner pen arrangements have been successfully developed in the industry. There is currently little information available on the environmental effects of these systems.

Following are guidelines for the management of weaners.

**Regular pen relocation**
The weaners can be housed in insulated shelter huts and small adjoining pens at the rate of 50 weaners per hectare. Each hut holds about 50 weaners. Clean straw bedding is continually added to the huts and every six weeks the hut and adjoining pen is relocated to a fresh site within the paddock.

An area equivalent to the total number of weaners, at 50 weaners per hectare, should be kept at rest and free of any input of nitrogen and phosphorus.

**Extended pen relocation.**
Small pens are constructed to hold about 200 weaners in a block. Each pen is “balanced” by resting an adjacent area of four hectares around the pens which is kept free of any additional nutrient input. The pens are maintained in any one location for not more than two years, when they are shifted to a completely new area. The weaners are bedded on straw which is completely removed and fresh straw replaced every six weeks.

**Straw management and disposal**
Remnant bedding straw from weaner pens that can not be exported from the property should be spread over as large an area of ground as possible and ploughed in. This should be undertaken so that the risk of stormwater carrying the straw and manure into nearby water courses is minimised.

*While the ‘wallow’ is an integral part of extensive rearing systems, care should be taken to ensure that serious land degradation does not occur.*
7.4 General land management issues

7.4.1 Permanent pig enclosures
Where permanent enclosures are used, pigs should not be stocked continuously. The land should be rested until a vegetation cover is re-established every year. During the fallow period of pasture regrowth, no additional fertiliser should be applied to the soil unless soil testing shows it is required to maintain healthy crops or pasture.

If the soil in an extensive piggery enclosure exhibits signs of compaction or excessive stormwater run-off, the pigs should be shifted to a new area carrying a good cover of pasture or stubble as soon as possible.

7.4.2 Fencing requirements
On existing piggeries, water courses should:

- be fenced off and a 50 metre separation distance effected for a minor water course and 100 metres for a major water course; and
- visual barriers should be erected if the piggery is sited within 50 metres of any property boundary fence or any road boundary.

To prevent pigs escaping from the area of the piggery, the boundary fences should be made secure. Where trees are located within the enclosures, robust, protective fences should be erected around each tree or group of trees (allowing at least one metre between the fence and the tree trunk).

7.4.3 Nutrient management
Managing rainfall and nutrient run-off can be optimised by contour ripping at 20 metre spacing during the winter to entrap the rainfall run-off and nutrients within the soil.

7.4.4 Wallow management
Where shade trees and wallows are used to keep pigs cool during periods of extreme heat, one or more wallows should be allowed to develop within each holding area. These should be kept moist throughout the summer months. Numerous, large or dry wallows should be avoided. Wallows should be ploughed over and the area revegetated during layoff periods.

7.4.5 Water troughs
Water troughs should be fitted with excess flow control devices so that any upturned or damaged troughs will not cause excessive flooding and localised erosion.
8: OTHER Waste Management ISSUES

8.1 Solid waste storage, use and disposal.

8.1.1 Storage of solids

Piggery solids should be stored within a low permeability compound lined with clay, concrete, high density polyethylene (HDPE) or other synthetic liners.

If wet manure is to be stored, it should be kept in an aerobic condition by rotating regularly until it is either dry or composted. If storage is necessary during the wet season, the finished material should, if practical, be stored in a weatherproof vented enclosure.

Where solids are to be dried prior to reuse or disposal (eg screened solids) the material should be spread in thin layers over suitably impermeable surfaces. For either wet storage or drying beds, the storage area should be drained back into the effluent treatment system or to a containment structure such as a tank or lagoon from which effluent can be treated and then reused or disposed of.

Dried solids should be regularly removed for subsequent use or disposal. Other considerations regarding the storage of solids, are odour, fly breeding and, for dried material, wind blown dust.

8.1.2 Use and/or disposal of piggery solids

Piggery solids, including straw based waste from shelters or extensive piggeries, should be seen as a resource rather than a waste and therefore reuse options should be considered wherever possible. Disposal to landfill or via incineration (whether in an actual incinerator or burning in the open) should be considered the last alternative.

Piggery solids, may be used either on or off site, as:

- soil conditioners;
- compost;
- fertiliser; or
- vermiculture.

Soil conditioning

The variety of trace elements and other chemicals found in waste can make this material useful as a soil additive and, if lime has been used to aid settling, there will be sufficient nitrogen and phosphorus compounds to act as fertiliser.

Except where environmental restrictions apply, solids can be applied directly to land as a soil conditioner. Soil conditioning is best achieved by ploughing or discing in the material so that it is not washed away by stormwater, and fly breeding is discouraged.

Composting

Properly decomposed compost made from pig faeces (and/or straw waste from shelters) is stable, relatively odourless and can be used as a soil conditioner and plant growth enhancer.

The composting process produces heat with temperatures reaching up to 70°C, pathogenic organisms are killed and many organic and nitrogenous compounds, water, and carbon dioxide are lost to the air as gases. Green waste or sawdust can be added to enable the composting process to achieve optimal carbon to nutrient balance.

If anaerobic conditions occur during composting odour is produced by volatile organic acids and methane is generated, so the ideal is to provide sufficient oxygen (aerobic conditions) to prevent this happening (Kruger et al., 1995).

A number of different composting techniques can be used, such as:

- aerated static piles - large scale batch processes that are cheap and easy to develop;
- passive - cheap batching process that tends to be slow to finalise;
- fumed windrows - process is effectively continuous and requires expensive turning machinery but has a very large throughput; and
- in-vessel - a capital intensive batching process.

Piggery operators should be aware that there are licensing requirements with the Department of Environmental Protection (DEP) for composting operations where 1000 tonnes or more of material are stored or composted per year.

The DEP’s Licensing Branch should be contacted for further information on this matter as well as for general requirements for composting (refer to Appendix 3 for contact numbers).

Composting of carcasses is addressed in section 8.2.

Fertiliser

Piggery solids (particularly dried solids, those resulting from centrifuging, or straw based waste) can be sold off site for market gardens, mushroom or worm farms, or for domestic garden use. Pelletising and bagging of waste solids prior to sale is another alternative.
8.2 Carcass disposal

Dead animals and other organic matter (such as afterbirth) are best dealt with separately from the usual effluent management process. The method used for dealing with this material will depend upon the size of the facility, the capital available and proximity to services. Either way, this material should be disposed of quickly.

There are four common techniques for proper carcass disposal:
- burial;
- rendering;
- burning; and
- composting.

Burial

This can be convenient for the operator but is not recommended where there are light sandy soils and/or a shallow water table due to the threat to groundwater quality caused by decaying carcasses.

Burial pits or trenches need to be dug on high ground well away from any buildings, streams, roads, water courses or unprotected groundwater. The trenches also need to be deep enough to prevent predators such as foxes, dogs and birds digging up the body. (Predators may spread disease if they can get to the carcasses). Once carcasses have been disposed of in the trench they need to be immediately covered with at least 500 millimetres of soil.

The addition of lime to carcasses prior to soil covering should also be considered as it assists the decomposition process as well as providing a deterrent to scavengers such as foxes.

Figure 3 provides a diagram showing how dead pigs should be disposed of by burial.

Rendering

A carcass collection service by a rendering company is available for properties near to Perth (refer to Appendix 3 for contact details). This service will accept fresh bodies (no more than 24 hours after death) for rendering, and will collect free of charge to the piggery if it is economical. Other offal and farrowing residues are also collected. The bodies are turned into commodities such as fats, paints, and meat and bone meal. All microbial disease organisms are destroyed in the rendering process.

Some country rendering facilities may also accept such waste. Enquiries should be made directly to such facilities for further information on this matter.

Burning

This is an option for isolated rural areas and minimises the risk of transferring diseases as well as totally destroying the carcasses. A simple wood fired pyre can be used on site but a properly constructed incinerator is preferable. Operators should consider the bush fire risk in the dry season and only burn when it is safe to do so. Burning is not an option in semi urban areas.

Composting

If proper care is taken, composting is suitable for all scales of piggeries and in all locations. The product is a humus like substance and the heat generated in the process (up to 70°C) helps to destroy disease organisms.

Composting should be carried out in an accessible and well drained area which can be kept free of rainwater and surface water runoff.

A carbon source must be added to aid the composting process and sawdust which is easily handled, absorbent and settles around the carcass is an ideal choice. Using sawdust also gives the minimum leaching from the area and helps to eliminate excessive moisture. Other carbon sources such as straw can be used but due to the poorer surface area to volume ratio, longer composting times are required. Liquids leaching from straw mixtures should also be managed.

Further information on composting can be found in Kruger et al (reference 20, Chapter 5). In addition, the Department of Environmental Protection should be contacted with respect to their current composting requirements.

Storage

In cases where is is necessary, carcasses should be temporarily stored in an insect and vermin proof container in a cool location.

8.3 Use and disposal of agricultural and veterinary chemicals

The Health (Pesticides) Regulations control the use of agricultural chemicals and regulate the disposal of waste chemicals and containers. (See appendix 2, section 5.3)

Where veterinary or other chemicals (eg pesticides) are used, particular care should be taken in the disposal of chemical containers and disused chemicals, as inappropriate disposal can cause environmental problems.

Further advice regarding disposal of unwanted chemicals may be obtained from either the Health Department or the Waste Management Division of the Department of Environmental Protection (refer to appendix 3).
Figure 3 Disposal pit for pig carcasses

Pig carcasses should be disposed of by burial where composting, incineration or delivery to a processor can not be arranged.
9: **Environmental Management Plans**

9.1 **Requirements of environmental management plans**

Each piggery should develop an environmental management plan (EMP) which includes methods of managing day-to-day environmental issues, such as waste treatment and disposal, as well as effective methods for dealing with any emergency that may arise. Such plans should also include any environmental monitoring requirements.

9.2 **Contingency plans**

Each piggery should be equipped to cope with contingencies such as:

- illness or disease in the stock;
- temporary or permanent loss of trained personnel;
- disruption or long term loss of power supply with resultant operational breakdowns such as pump, heating, cooling, drainage failure;
- effects of floods, fire, storms, earthquake or other natural disasters;
- breakdown or disruption to any part of the water or food supply, or of the effluent treatment system;
- overflow of the effluent treatment system; and
- vandalism to any equipment, plant or storage facilities.

Such a plan should be regularly updated and all staff should be made thoroughly aware of the scheme and be trained to carry out their role (ARMCANZ, 1995).

9.3 **Monitoring**

In order to properly assess the performance of a piggery effluent treatment system, management must be able to ascertain the effects of the treatment system, including the impact of effluent and solids disposal.

Appropriate monitoring processes for water quantity and quality, input and output, should be incorporated in the planning and operation of the piggery. As well as allowing the environmental effect of the piggery to be supervised, good monitoring practices establish the environmental management credentials for the piggery. Critics, either regulatory or from the local area, can be more readily appeased if good data is available.

Monitoring is the primary way of establishing how well the management system is operating. The extent of monitoring will depend on the size, scale and nature of the piggery, the proximity of any developed or urban areas, and the nature of the local environment.

Reporting of monitoring results should be included both as part of its EMP, and to properly comply with the requirements of regulatory agencies such as the Department of Environmental Protection and the Water and Rivers Commission.

Water usage should be accurately monitored in order to gauge the operating efficiency of the enterprise. Effluent should be regularly monitored for chemical composition both before and after treatment. Runoff quality and quantity should be monitored. Monitoring bores should be used to ascertain groundwater quality where the water is to be utilised for drinking or other purposes and is at risk of contamination, or where groundwater is downstream of any effluent disposal process. Guidelines are available from the Water and Rivers Commission regarding appropriate sampling methods.
The composition of the effluent stream will vary from piggery to piggery based upon factors such as housing systems, pig management, breed, age, nutrition and season.

Water quality data should be monitored regularly in order to be able to better manage the treatment process and especially where land application of effluent is part of the system.

Ideally, where waste is to be applied to the land, effluent samples should be analysed by a NATA approved laboratory for the following:

- electrical conductivity (EC), hence total dissolved solids (TDS) may be derived;
- pH;
- total suspended solids (TSS);
- biochemical oxygen demand (BOD) or chemical oxygen demand (COD);
- organic carbon;
- exchangeable cations (sodium, magnesium and calcium);
- sodium absorption ratio (SAR) if treated effluent is irrigated on to clay soils;
- nitrogen (as total nitrogen, ammonia and nitrate/nitrite);
- total phosphorus;
- potassium;
- sulphate;
- copper, zinc and other metals; and
- pathogenic microorganisms.

Sampling and analysis should occur at a minimum of six monthly intervals and more frequently when new or upgraded treatment methods are used or environmental concerns arise.

In order to calculate application rates prior to land application, nutrient concentrations, salinity, BOD, TDS, TSS and organic matter should be tested for prior to application (ARMCANZ, 1995).

Solids should be utilised in a manner which is environmentally acceptable and useful for the enterprise. Complete records should be kept which allow the total salts, contaminants and nutrients to be calculated for all land areas where solid waste has been applied. Records could also include monitoring vegetation for health, growth rate and yield.

Application of solids to land should not produce polluted runoff, a change in pH, or the addition of salts, pathogens or nutrients to groundwater or surface water bodies. The community perception of the amenity should not be reduced (any complaints should be noted) and there should be no degradation of the soils where solid waste has been utilised (ARMCANZ, 1995).

9.4 Reporting

Reporting of monitoring data will depend on reporting requirements which may be prescribed in licence approval conditions from the Department of Environmental Protection, Water and Rivers Commission or relevant local government.

Data should be stored safely and when required, summarised in tabular and/or graphical form. Each report should include an explanation of any anomaly in monitoring or reporting and any procedures used to fix the aberration. Any missing data should be noted along with possible explanations for its absence. Clarification is needed if it was not possible to take the relevant samples. Any other problems which may have been encountered should be explained.

Finally, any proposed expansion to the piggery, improvements or changes in effluent treatment (e.g. the implementation of vermiculture practices, selling compost off site, use of shelters) should be noted, and where necessary appropriate approvals sought, or if already gained, cited.
REFERENCES


Bent, M.J.M., Executive Officer, Western Australian Pig Industry Export Development Committee. Personal communication, 1997.


Moore, G. Co-owner of Janannie Farm, Alexander Rd., HARVEY, personal communication.


Ryan, P.N. Program Manager, Assessment and Advice, Policy and Planning Division, Water and Rivers Commission (Personal communication)


Western Australian Pig Industry Export Development Committee (1998), Export and Investment Opportunities in the Western Australian Pig Industry.


Western Australian Pork Producers' Association 1997), per.comm (response to Draft Guidelines).
**APPENDIX 1: GLOSSARY OF TERMS & ABBREVIATIONS**

**Aquifer:** A geological formation or group of formations able to receive, transmit and store significant amounts of water.

**ARMCANZ:** Agriculture and Resource Management Council of Australia and New Zealand.

**Baconer (see also Finisher):** A pig grown for use in the processed meat industry and between 14 and 26 weeks old at slaughter.

**Beneficial Use (of water):** This is a value or use established for a particular segment of a water resource such as environment, public water source, agriculture, mining, industry supply, or aesthetic or recreational waters and which requires protection from pollution.

**Biochemical Oxygen Demand (BOD):** Is the amount of oxygen required by aerobic organisms to carry out biochemical oxidation. It is widely used as a measure of pollution in water and is expressed as a unit load per volume of water (eg mg/L) at a given temperature and for a given time. The more organic matter in the sample, the more oxygen is used by the organisms.

**Boar:** An adult male pig used for breeding.

**Colloidal State:** Particulate matter in suspension with particle diameters ranging from 10^-9 m to 10^-7 m which is not a true molecular solution.

**Confined Aquifer:** A formation in which the groundwater is isolated from the atmosphere at the point of discharge by impermeable geologic formations; confined groundwater is generally subject to pressure greater than atmospheric.

**Contamination:** Is the addition of matter to water which causes an alteration in its characteristic water quality and produces an observable or detectable change.

**DOLA:** Department of Lands Administration

**Effluent:** In a piggery, refers to the mixture of faeces (both solid and liquid), urine, washing or flushing water, spilt drinking water and pipeline leaks which may contribute to the above.

**Farrowing:** Production or birth of a litter of pigs.

**Finisher (see also Baconer):** A pig grown for use in either the fresh or processed meat industry and between 14 and 26 weeks old at slaughter.

**Flocculation:** To form an aggregated mass of small particles usually from a fine suspension or colloid. A flocculant can settle out of a liquid or be readily filtered.

**Gilt:** Female pig having reached adult maturity and selected for breeding purposes, but not having had a litter.

**Grower:** Young growing pig in the range of about 8 to 14 weeks old.

**ha:** hectares

**mg/L:** milligrams per litre

**NATA:** National Association of Testing Authorities

**Pathogen:** A disease producing organism (usually microscopic).

**Phosphorus Retention Index (PRI):** PRI is defined as the ratio of phosphorus adsorbed by the soil (P_{ads}) to the equilibrium concentration of phosphorus (P_{eq}).

**Piggery:** Is any building, enclosure, or yard in which one or more pigs are kept, bred, reared, or fattened for purposes of trade (Health Act 1911).

**Piglet (see also Sucker):** A young pig not yet weaned and typically less than 5 weeks old.

**PRDC:** The Pig Research and Development Corporation.

**Sow:** Adult female pig that has produced at least one litter.

**Struvite:** This is the crystalline form of magnesium ammonium phosphate hexahydrate (Dana and Ford, 1966) which forms a hard scale inside pipes and fittings.

**Sucker (see also Piglet):** A young pig not yet weaned and typically less than 5 weeks old.

**Surface Water:** This is all water on the land surface, fresh and saline and includes wetlands, lakes, rivers, streams, estuaries and manufactured ponds, reservoirs and lakes.

**Total Dissolved Solids (TDS):** The total amount of dissolved salts in a water sample, usually expressed in milligrams per litre (ie parts per million).

**Total Suspended Solids (TSS):** The total amount of suspended solids in a water sample, usually expressed in milligrams per litre (ie parts per million).

**Volatile Organics:** Organic compounds which are readily turned into the gaseous state and therefore are driven off into the atmosphere from the parent material.

**Volatile Suspended Solids (VSS):** The total amount of solids which can be driven off as gases when the material is heated to 600°C for 20 minutes.

**WAPPA:** The Western Australian Pork Producer’s Association.

**Water pollution:** Is the state of contamination for which water quality has deteriorated to the extent that the water is no longer able to sustain the beneficial use for which it was identified.

**Water Quality Indicator:** This is a chemical compound or characteristic in water which can be measured and used as a standard of quality.

**Weaner:** This is a weaned pig of about three to eight weeks of age.
APPENDIX 2: LEGAL REQUIREMENTS

A2.1 Relevant Acts in Western Australia

The following discussion provides information regarding the legislation affecting the establishment and/or operation of a piggery in Western Australia, in particular the Acts under which the approvals referred to Chapter 2 must be gained.

A2.2 Planning requirements

Health Act 1911
State Planning Commission Act 1985
Town Planning Development Act 1928
Local Government Act 1996

In Western Australia, piggeries are defined under the Health Act 1911 as an offensive trade when situated in a prescribed area and may only be established in such area with the approval of the local government. In such cases, piggeries must be registered with the local government on an annual basis.

The Western Australian Planning Commission is responsible for land use zoning in this State. Generally, the local government will have a planning scheme and by-laws to govern land use. Therefore, the first step in obtaining approval to establish a piggery is to contact the local Shire or City Council. There should be no encumbrance, provided the piggery is to contact the local Shire or City Council. Responsible for land use zoning in this State. The Western Australian Planning Commission is responsible for land use zoning in this State. In particular the Acts under which the approvals referred to Chapter 2 must be gained.

A2.3 Environmental requirements

Environmental Protection Act 1986
Water and Rivers Commission Act 1995
Waterways Conservation Act 1976
Rights in Water and Irrigation Act 1914
Soil and Land Conservation Act 1945
Metropolitan Water Supply Sewerage and Drainage Act 1909
Country Areas Water Supply Act 1947

A2.3.1 Environmental Protection Act 1986

This Act is the main piece of legislation for dealing with pollution prevention in Western Australia. The Act gives the Environmental Protection Authority (EPA) and the Department of Environmental Protection (DEP), in conjunction with advice from other regulatory bodies, the power to prevent pollution from industry. This Act allows for the protection of natural resources by the establishment of State environmental protection policies, the control of pollution and implementation of the environmental impact assessment process. It also gives the Department of Environmental Protection the right to control polluting activities, apply penalties for contravention of the Act and impose pollution abatement notices (PANs).

In particular the Act allows for the control of "prescribed premises" (that is premises which have a known potential to pollute) through approvals required for construction and operation of such premises (EPA, 1991).

Under the pollution control provisions of the Environmental Protection Act 1986, a works approval is required for the construction of such premises and a license or registration is required for their operation. It is an offence to commence any such construction without a works approval or to operate a prescribed premises without the necessary licence or registration.

Under the Environmental Protection Regulations 1987 (as amended), intensive piggeries of a certain size are defined as prescribed premises and the Department of Environmental Protection approval requirements are as follows for an intensive piggery; that is, "premises on which pigs are fed, watered and housed in pens within sheds".

<table>
<thead>
<tr>
<th>Definition</th>
<th>Approvals Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>more than 500, less than 1000 animals</td>
<td>works approval to construct, registration to operate</td>
</tr>
<tr>
<td>1000 animals or more</td>
<td>works approval to construct, licence to operate</td>
</tr>
</tbody>
</table>

A works approval or licence is currently not required for either extensive or alternate straw based housing ("semi-intensive" housing).

Non-prescribed premises

As can be seen above, some piggeries due to their size or the nature of their operation (or both), are not considered to be prescribed premises and therefore do not require a works approval, licence or even registration under the Environmental Protection Act 1986. Examples of this type of piggery include intensive piggeries with less than 500 pigs in total, extensive piggeries, and facilities that utilise alternate straw based housing structures. Other approvals such as local government approval, (planning and/or building approval, Offensive Trade - consent and registration) could still be required. Also, in any of these cases, any person may still refer a proposal for an extensive or semi-intensive piggery or small intensive piggery to the EPA for subsequent environmental impact assessment.

Despite the absence of formal controls provided by the Department of Environmental Protection, the operator is still responsible for ensuring the piggery is constructed, managed and operated in an environmentally acceptable manner. The operator is therefore encouraged to follow these guidelines and other existing codes of practice or guidelines, and to contact Water and Rivers Commission, Department of Environmental Protection and Agriculture Western Australia for advice regarding environmentally acceptable practices.
A2.3.2 Water and Rivers Commission Act 1995

Under this Act, the Commission has responsibility for the conservation, protection and management of the State’s water resources. The Commission is also responsible for administering the following Acts:

- Waterways Conservation Act 1976 (WC Act)
- Rights in Water and Irrigation Act 1914 (RIWI Act)
- Metropolitan Water Supply, Sewerage and Drainage Act 1909 (MWSS&D Act)
- Country Areas Water Supply Act 1947 (CAWS Act)
- Metropolitan Water Authority Act 1982 (MWA Act)

Waterways Conservation

Under the provisions of the WC Act, the Commission has a waterways management and protection function and associated powers in respect of designated waterways (Swan River, Avon River, Peel Inlet, Leschenault Inlet, Albany Waterways, Wilson Inlet) and adjoining land in management areas declared under the Act. This adjoining land extends to the entire catchments of the Avon River, Albany Waterways and Wilson Inlet.

Water Allocation

The RIWI Act covers the licensing of bores and abstraction of water from proclaimed rivers and streams. Licenses are only required in proclaimed groundwater and surface water areas. In addition, all artesian wells need to be licensed.

Public Drinking Water Source Areas

The quality of public drinking water sources is protected by proclaiming Underground Water Pollution Control Areas, Catchment Areas and Water Reserves under the MWSS&D and CAWS Acts.

The by-laws under the MWSS&D and the CAWS Act enable the Water and Rivers Commission to control potentially polluting activities, to regulate land use, inspect premises and to take steps to prevent or clean up pollution.

In public drinking water source areas, the Commission has defined three levels of priority classification as follows:

Priority 1 (P1) source protection areas are defined to ensure that there is no degradation of the water source. P1 areas are declared over land where the provision of the highest quality public drinking water is the prime beneficial land use. P1 areas are managed in accordance with the principle of risk avoidance.

Priority 2 (P2) source protection areas are defined to ensure that there is no increased risk of pollution to the water source. P2 areas are declared over land where provision of public water supply is a high priority. P2 areas are managed in accordance with the principle of risk minimisation.

Priority 3 (P3) source protection areas are defined to minimise the risk of pollution to the water source. P3 areas are declared over land where water supply needs to co-exist with other land uses such as residential, commercial and light industrial developments. Protection of P3 areas is achieved through management guidelines rather than restrictions on land use.

In addition to priority classification, wellhead protection zones and reservoir protection zones are defined to protect the water source from contamination in the immediate vicinity of production wells and reservoirs. Additional restrictions apply within these zones.

A2.3.3 Soil and Land Conservation Act 1982

The Soil and Land Conservation Act 1982 includes as its objectives, the conservation of soil and land resources and the mitigation of the effects of erosion, excessive salinity and flooding. The general loss of productive capacity or land degradation includes soil erosion, excessive soil and stream salinity, waterlogging, flooding and nutrient enrichment causing harm to animal and plant life. In addition, the removal or deterioration of natural or introduced vegetation that may be detrimental to the present or future use of land is considered as land degradation.

Soil and land conservation requires the use of appropriate land management to attain or maintain the stability of that land in perpetuity. In the context of the legislation, land conservation is the application of appropriate land use.

Where a land holder causes land degradation and this is brought to the attention of the Commissioner, after consultation the Commissioner can issue a ‘Notice’ directing the land holder to rectify the situation.
A2.4 Requirements of the Health Act 1911

Usually under the Health Act 1911 a piggery is defined as an offensive trade. It therefore requires special local government approval for establishment and then only in prescribed areas. A piggery classified as an offensive trade, must be registered annually with the local government and a fee paid. An appeal may be made to the Executive Director, Public Health in the event of a licence being refused or not renewed.

Local laws made under the Health Act 1911 in regard to the establishment and registration of a piggery provide operation and construction standards for a piggery. The Act specifically stipulates that uncooked offal must not be fed to pigs. The Act also provides the “Power to seize and destroy pigs, etc., trespassing on rivers, etc”. Specifically, local government “may cause to be conspicuously posted in the neighbourhood of any water supply notice which is enacted in WA by enabling legislation, that the water thereof is required for drinking purposes, and that pigs, dogs, ducks, and geese are prohibited from trespassing thereon”. It goes on to specify that a person allowing such trespass is committing an offence and provides for the animals to be destroyed or sold on behalf of the local government (Health Act 1911).

A2.5 Other Requirements

Stock (Identification and Movement) Act 1970
Bush Fires Act 1954
Agricultural and Veterinary Chemicals Code Act 1994 (Commonwealth)
Veterinary Preparations and Animal Feeding Stuffs Act 1976
Health (Pesticides) Regulations 1956

A2.5.1 Stock (Identification and Movement) Act 1970
(formally the ‘The Brands Act’)

This Act was amended to the above in 1995 and was previously known as the Stock Brands and Movement Act 1970. It requires that when pigs over the age of ten weeks are sold, a registered tattoo must be branded on the animal within seven days prior to it leaving the property. All pig producers must register a brand which can be done by applying to any office of Agriculture Western Australia.

A2.5.2 Bush Fires Act 1954

The Bush Fires Act provides for a Board to administer the Act and authorised officers in local authorities are appointed by the Board. An authorised officer may inspect fire precaution measures taken on an extensive piggery and examine anything which he or she considers to be a fire hazard existing on the land. This could include the inspection of any electric fencing and associated electrical fittings. By powers vested by the Board, an approved local authority may prohibit the use of any vehicle on land within the district during periods of extreme or very high fire danger.

(Department of Environmental Protection, 1995)
APPENDIX 3: USEFUL CONTACTS

The following details were correct at the time of publishing. Actual officers may change over time.

AGRICULTURE WESTERN AUSTRALIA

Research and Development Services
3 Baron-Hay Court SOUTH PERTH 6151
phone (08) 9368 3341 fax (08) 9474 1295
Contact John Noonan (9368 3570)
Hugh Payne (9368 3576)
Postal address Locked Mail Bag 4,
BENTLEY DELIVERY CENTRE 6983
Internet www.agric.wa.gov.au/pork

Agriculture WA has many publications of relevance to piggeries, providing information on housing, nutrition, breeding and so forth. Several publications are applicable to environmental management of piggeries.

Agriculture Western Australia also operates a research facility at Medina where piggery projects are carried out. A team of pork industry specialists within the Animal Research and Development Services Unit can provide further information and advice. (Telephone: (08) 9368 3333).

BUREAU OF METEOROLOGY

6th Floor, 1100 Hay Street
PERTH 6000
Postal address P.O. Box 1370
WEST PERTH 6872
phone (08) 9263 2222
Internet www.bom.gov.au

DEPARTMENT OF ENVIRONMENTAL PROTECTION

Head Office
Westralia Square
141 St Georges Terrace
PERTH 6000
phone (08) 9222 7000 fax (08) 9222 7099
Contact Jenine Ryle (08) 9222 7024
Internet www.environ.wa.gov.au

Regional Offices:-
Kwinana Region Office
Gilmore Avenue (PO Box 454)
KWINANA 6167
phone (08) 9419 5500 fax (08) 9419 5897

South West Region Office
65 Wittenoom Street (PO Box 156)
BUNBURY 6230
phone (08) 97214 814 fax (08) 9722 0481

Mid West Region Office
5 Burgess Street
GERALDTON 6530
phone (08) 99643 844 fax (08) 99643 681

Goldfields Region Office
Viskovitch House, 377 Hannan Street
KALGOORLIE 6430
phone (08) 90213 243 fax (08) 90213 529

Pilbara Region Office
SGIO Building,
Welcome Road (PO Box 276)
KARRATHA 6714
phone (08) 91431499 fax (08) 91441326
HEALTH DEPARTMENT OF WA

Applied Environmental Health
227 Stubbs Terrace
SHENTON PARK 6008

Postal PO Box 8172
Stirling Street
PERTH 6849

Phone (08) 9388 4999 Fax (08) 9388 4955

Internet www.health.wa.gov.au

WATER & RIVERS COMMISSION

Head Office
Level 2, Hyatt Centre
3 Plain Street
EAST PERTH 6004

Phone (08) 9278 0300 Fax (08) 9278 0585

Internet www.wrc.wa.gov.au

Regional Offices:

Mid West Gascoyne
Pass Street
GERALDTON 6530

Phone (08) 9964 5978 Fax (08) 9964 5983

North West
Chiratta Road
KARRATHA 6714

Phone (08) 9144 2000 Fax (08) 9144 2610

South Coast
5 Bevan Street
ALBANY 6350

Phone (08) 9842 5760 Fax (08) 9842 1204

South West
Unit 2 Leschenault Quays
Austral Parade
BUNBURY 6230

Phone (08) 9721 0666 Fax (08) 9721 0600

Or

'Shell House', 21 Sholl Street
MANDURAH 6210

Phone (08) 9535 3411 Fax (08) 9581 4560

Swan-Goldfields-Agricultural
849 Albany Highway
VICTORIA PARK 6100

Phone (08) 9362 0555 Fax (08) 9362 0500

Or

254 Fitzgerald Street
NORTHAM 6401

Phone (08) 9690 2821 Fax (08) 9622 7155

WESTERN AUSTRALIAN PORK PRODUCERS' ASSOCIATION

PO Box 6291
EAST PERTH 6892

Phone (08) 9325 2933 Fax (08) 9325 4197

Contact Executive Officer Lea Newing

PIG RESEARCH AND DEVELOPMENT CORPORATION

3rd Floor, Industry House
10 National Circuit
BARTON ACT 2600

Phone (06) 272 5139 or 272 4531 Fax (06) 272 5879

Postal PO Box 4804
KINGSTON ACT 2604

Contact Chairman Dr Rob Wilson
Executive Director Dr Tony Peacock

AUSTRALIA AND NEW ZEALAND ENVIRONMENT AND CONSERVATION COUNCIL

The Secretary Australia and New Zealand Environment and Conservation Council
GPO Box 787
CANBERRA ACT 2601

Phone (02) 6274 1428 Fax (02) 6274 1858

CARCASS COLLECTION & RENDERING SERVICES

Tallowman (Derby Industries Pty Ltd) Lakes Road, HAZELMERE

Phone (08) 9274 3755
INDEX

A
Acts. See Environmental Protection Act; Health Act; Water and Rivers Commission Act Agricultural and Veterinary Chemicals Code 41 Albany Waterways 40 Ammonia 7, 14 ammonium carbonate 5 Anaerobic bacteria 14 oxygenated conditions 14 Anaerobic pond 14 ARMCANZ 30

B
Bacteria 5 BOD 30 Buffer 10, 11, 12, 17, 19, 32 Buffer zones 10, 11, 39 Bush Fires Act 41

C
Calcium 30 Carbon dioxide 7 Climate 9 Colloids colloidal 13 Compost 25. See also Waste management Composting 25 Copper 30

D
Darling Scarp 9

E
Effluent reuse 16, 30 Effluent management 13 Effluent treatment 13 centrifuging 13 design criteria 17 screening 13 solids separation 13 Environmental Protection Act 39 Evaporation ponds 16 Excreta 5. See also Waste management

F
Faecal matter 5 Fertiliser 25. See also Waste management Flocculant Chemical treatment 14

H
Health (Pesticides) Regulations 41 Health Act requirements 41 Health Department 26 Heavy metals 14. See also Selenium; Zinc Hydrogen sulphide 7, 14

I
Insects 6

L
Legal Requirements new piggeries 3 Lighting 6

M
Magnesium 5, 30 Manganese 5 Methane 7 Methane digesters 16 microorganisms 5

N
New piggeries approvals required 3 legal requirements 3 licencing new piggeries prescribed premises 39 planning requirements 39 Nitrogen 5, 6, 12, 13, 14, 16, 18, 23, 25, 30, 31 ammonification 5 ammonium carbonate 5 hydrolysis 5 Noise control 6

O
Odour 6, 11, 13, 17 Oxygen demand 14 biochemical oxygen demand (BOD) 30 chemical oxygen demand (COD 30

P
Parasites 5 Pathogenic bacteria. See Bacteria Pesticide regulations 41 Phosphorus 5, 6, 12, 13, 14, 18, 23, 25, 30, 31 Phosphorus retention index. See PRI Piggeries straw based housing 2 Piggery waste chemical components 5 Planning requirements 39 Polymers 14 Potassium 30 PRI 12 Protozoa 5 Public Drinking Water Source Areas 12, 40
S
Salinity 30
Salmonella 5
Selenium 5
Site Selection 9
Sodium 30
Sodium absorption ratio (SAR) 30
Soil and Land Conservation Act 40
Soil conditioning. 25 See also Waste management
Soils 12
surface compaction 6
Stabilisation ponds 14
Stock (Identification and Movement) Act 41
Stormwater 13
Straw 19, 21, 23, 25, 26
Straw based housing
Straw 5
Sulphates 30
Swan Coastal Plain 9

T
TDS 30
Topography 12
TSS 30

V
Vegetation 12
Veterinary Preparations & Animal Feeding Stuffs 41
Viruses 5
Volatile fatty acids 14

W
Waste management 11, 12, 19, 25, 26
Water allocation 40
Water and Rivers Commission Act 40
Water requirements of pigs 11
Water supply 11
Water wastage
drinker leakage 5
Waterways
Avon River 40
Leschenault Inlet 40
Peel Inlet 40
Swan River 40
Wilson Inlet 40
Waterways Conservation 40
Welfare 11

Z
Zinc 5, 30. See also Heavy metals