NATIONAL WATER QUALITY
MANAGEMENT STRATEGY

EFFLUENT MANAGEMENT GUIDELINES FOR DAIRY PROCESSING IN AUSTRALIA

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AGRICULTURE AND RESOURCE MANAGEMENT COUNCIL OF AUSTRALIA AND NEW ZEALAND

AUSTRALIAN AND NEW ZEALAND ENVIRONMENT AND CONSERVATION COUNCIL

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PREAMBLE

This document is one of a suite of documents forming the National Water Quality Management Strategy (NWQMS). This Strategy aims to achieve the sustainable use of the nation's water resources by protecting and enhancing their quality, while maintaining economic and social development.

The Effluent Management Guidelines series, covers guidelines for specific industries. Six separate documents deal with specific industries as set out in Figure 1. This document provides national Effluent Management Guidelines for Dairy Processing Plants. It sets out principles that can form the basis for a common and national approach to effluent management for the dairy industry throughout Australia.

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Figure 1: Structure of the Effluent Management Guidelines for specific industries

Further information on the National Water Quality Management Strategy is given in Appendix A.

While prepared by a joint ANZECC/ARMCANZ working group these guidelines are designed primarily for the Australian situation, in recognition of the different legislative framework in New Zealand. However they could serve as a basis for discussion in New Zealand on the issues addressed in the guidelines.

1 INTRODUCTION

The dairy industry, including dairy farms and dairy processing plants, is Australia's fourth largest rural industry in terms of gross value of production. Annual sales total more than $5,000 million at the factory gate, and between $2,600 million to $5,000 million at the farm gate. It directly employs some 50,000 people, and another 50,000 in the indirect provision of services. The industry operates in all States, with Victoria accounting for more than 60 per cent of the national output. Additional information on the industry is provided in Appendix B.

The two main dairy processing areas into which milk is directed are:

- the market milk area, in which milk is processed, usually in plants in urban areas for immediate fresh consumption
- the manufacture of dairy products such as cheese, butter and milk powders in plants that are generally located in rural areas.

1.1 Objective of the guidelines

The objective in developing the *Effluent Management Guidelines for Dairy Processing Plants in Australia* is to ensure a nationally consistent approach to effluent management for the dairy processing industry throughout Australia.

The Guidelines can serve as a basis for sustainable resource development extension programs and for negotiations between regulatory authorities, local government and the industry, on conditions for managing, monitoring and reporting for effluent management that should apply at the regional level. They are sufficiently flexible to serve as a framework for developing both codes of practice, and general industry agreements, as well as the range of legislative controls around Australia. It is not practicable to produce guidelines which will be immediately applicable to licensing in all jurisdictions without adaptation to and discussion of local needs and conditions.

These Guidelines would be one of a number of documents that may need to be used for the overall environmental management of a particular dairy processing plant, since they deal with effluents, and associated solid components including sludge, not total site management.

The Guidelines will be reviewed as appropriate, but it could be reasonably expected that this would be within three years.

1.2 Environmental objectives

The Guidelines' main environmental objectives are that the proper siting, establishment and operation of the dairy processing plant should:

- maintain the environmental values of surface and groundwaters, including their ecology, by minimising the discharges of effluents containing organic matter, nutrients, salts or chemical constituents;
- minimise the effect of effluent addition to land, which may lead to the degradation of soil structure, salinisation, waterlogging, chemical contamination or erosion; and
- avoid off-site nuisance or interference with amenity, such as odours associated with inappropriate or poorly-operated waste treatment processes.

Achievement of these environmental objectives requires that dairy processing operations throughout Australia should be managed to protect:

- surface waters
- groundwaters
- soils
- vegetation
- public amenity.

1.3 Application of guidelines.

These Guidelines are intended for use by the dairy processing industry (including consultants), regulators, planning authorities and the broader community.

The industry

The Guidelines aim to:

- assist operators of dairy processing plants to minimise and as far as possible, use the effluent they produce
- prevent the unacceptable degradation of water, land and environmental quality.

The Guidelines should be consulted in conjunction with existing regulations, where extensions or new developments are planned, or where environmental protection at existing operations is to be enhanced.

Regulators and planning authorities

Effluent Management Guidelines for Dairy Processing Plants should provide the framework where guidelines or codes of practice are to be developed for regulating dairy processing plants. Any such State or local guidelines should be consistent with these Guidelines. Existing codes of practice or regulations should be consistent with and at least as stringent as these Guidelines.

In general, State, Territory, regional and local government guidelines, laws and regulations will be more detailed than these Guidelines to take account of the specific circumstances of the dairy processing industry in different areas. Local knowledge and data specific to individual dairy processing plants is essential to manage dairy processing plants responsibly.

The broader community

Integrated catchment management is increasingly becoming the "umbrella" for sustainable natural resource management. It provides the framework for the community, industry and government to work together to overcome environmental and resource management problems.

This document provides information which will help communities to participate in an informed manner in integrated catchment management, including decisions on new or existing dairy processing developments and local resource management issues. Development of catchment-based plans and strategies is central to integrated catchment management.

Further information

The development of detailed guidelines and environmental codes of practice is the responsibility of relevant State and Territory authorities. Proponents are thus encouraged to seek advice from the relevant State and Territory authorities about current regulations and codes of practice when new developments are being contemplated, or when the effluent management system of existing operations is to be upgraded.

Where further information is required to assist decisions relating to the management of effluent, reference should be made as appropriate to other National Water Quality Management Strategy documents (Appendix A) or the sources listed in Appendices C and D.

These guidelines should apply immediately to any expansion and new developments, and be phased in for existing facilities to timetables agreed with State and local government authorities.

2 PRINCIPLES OF ENVIRONMENTAL MANAGEMENT

The main principles of effective environmental management of effluent, in order of importance, are:

- avoidance or elimination of excessive waste generation through better planning
- optimisation of waste management processes
- effective and feasible recycling and reuse of effluent
- disposal, where its use is not practicable, in a manner that will not cause short or long term adverse environmental impact.

A fundamental consideration for sustainable management of dairy processing effluent should be the development of an Environmental Management Plan through the implementation of an Environmental Management System. In some States an operator can be required to produce an Environmental Management Plan as a stand alone document, not as part of an Environmental Management System. The amount of detail provided in the plan will depend on the size of the enterprise, siting considerations in relation to neighbouring communities and the environmental sensitivity of the location such as proximity to surface and groundwater. The Environmental Management System provides for the management, administration and monitoring framework for an operation's environmental aspects. It includes the principles of Total Quality Management and should incorporate the principles of risk management.

In August 1995, the International Standards Organisation (ISO) released the draft international standard ISO 14001 on *Environmental Management Systems: Specification with guidance for use*. In late 1995 ISO 14001 was published as an interim standard within Australia and New Zealand by Standards Australia. This standard can be used to provide guidance when implementing an Environmental Management System.

The Environmental Management System should incorporate the principles of cleaner production to minimise the adverse environmental impacts of the production process. In the context of these Guidelines, cleaner production involves the use of :

- better housekeeping
- improved management practices
- state-of-the-art in-plant production processes
- the concept of environmental management of all aspects of the entire production process, from the raw materials to finished product, including any associated waste.

Effective effluent management is an important part of a dairy processing operation, and should be allocated an appropriate share of management effort and expenditure. Good communication within the operation is important for increasing overall efficiency including effective environmental management, and ensuring that problems are identified early and rectified before they become significant.

To achieve the objectives of these Guidelines, it is important the Environmental Management System for the operation considers:

- possible future expansion for both existing operations and new developments
- other land uses and activities in the catchment or local area.

Development of an Environmental Management System and/or Plan should involve consultation with regulators, planning authorities and the broader community. State and Territory environment protection authorities can provide information on the development of Environmental Management Systems and/or Plans.

It is strongly recommended that professional consultancy advice be sought in the development and implementation of an Environmental Management System, and that all applications for a new or expanded dairy processing plant should be accompanied by a plan for such a System.

3 GENERAL CHARACTERISTICS OF DAIRY PROCESSING EFFLUENT

While effluent problems vary widely between fresh milk and dairy product manufacturing plants, neither plant creates toxic effluent.

Effluent contains milk and milk products from tanker washdown, equipment and pipeline cleaning, product changeover, spillage, as well as nutrients, detergents and sanitisers, dissolved solids including sodium chloride, and small amounts of lubricants. Effluents containing discarded milk or milk product can have particularly high Biochemical Oxygen Demand (BOD) concentrations. Dissolved solids may derive from either chemicals used in the manufacturing process, or the primary water source for the operation.

The large volumes of whey produced from cheese or casein (milk protein) manufacture may be further processed into commercially valuable protein products and bulking agents thus reducing the BOD level in the effluent stream. While the subsequent processing results in reduced volume, the concentration of dissolved solids in separate effluent streams may increase from regeneration of ion exchange resins or membrane filtration backwash. For a general representation of dairy processing effluent management, see Figure 2.

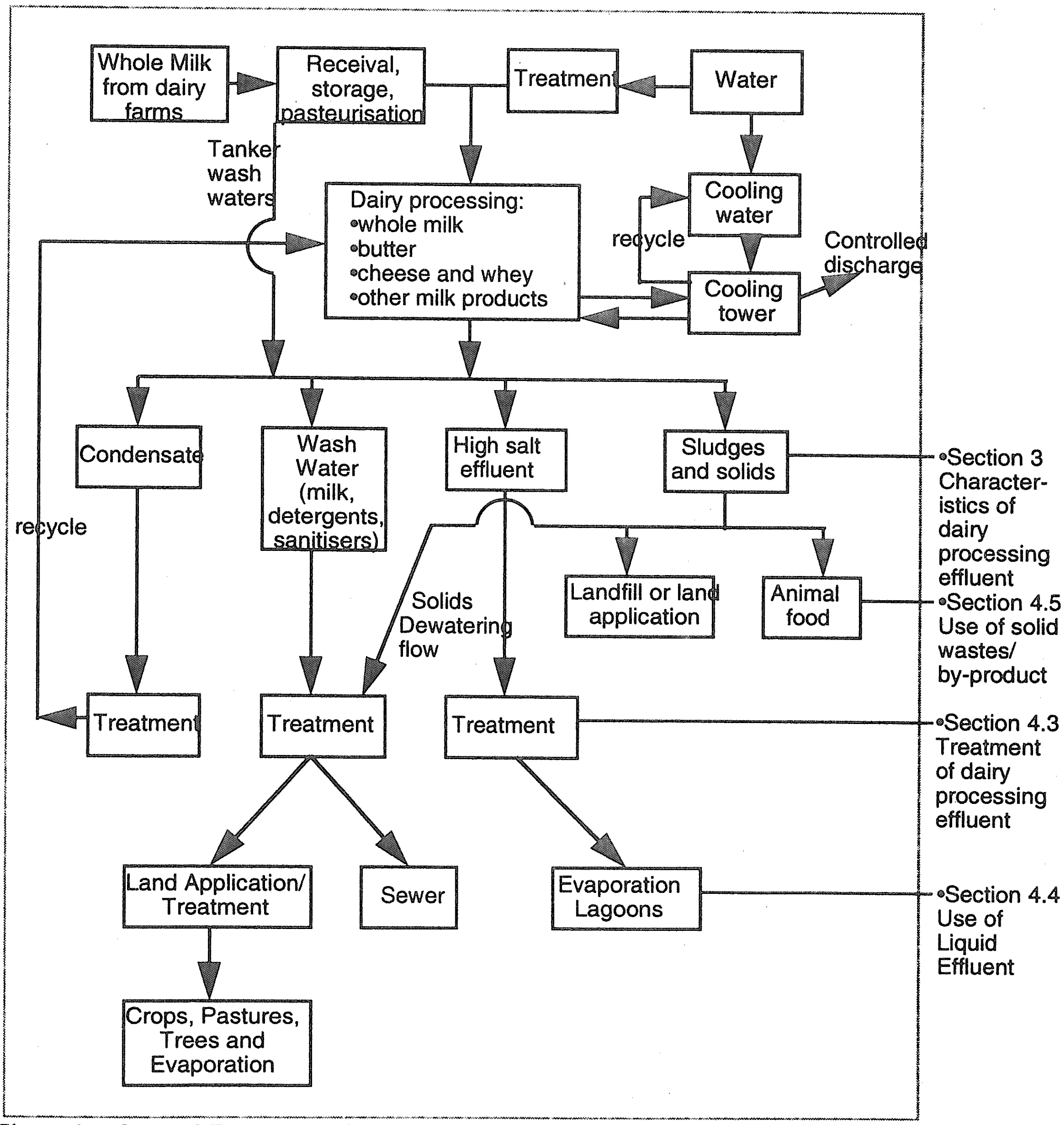

Figure 2: General Representation of Dairy Processing Effluent Management

Tables 1 and 2 provide information on the indicative composition of dairy processing effluent and BOD levels in milk and milk products respectively. As the information in Table 1 is indicative only, site specific information on the particular effluent stream should be obtained for modelling purposes when developing effluent management processes. It should be noted that the characterisation of the effluent(s) of a particular enterprise is fundamental to the operation and management of that enterprise and for adequate assessment for any land application program. Collection of data by dairy processing plant operators for the purposes of characterisation of the effluent is essential.

Table 1. Indicative Composition of Dairy Processing Plant Effluent**

Component	Range (mg/L)	Average (mg/L)
Suspended solids	24-5700	-
Volatile suspended solids	17-5260	-
Volatile total solids	57-4700	1497
Total solids	135-8500	2397
BOD_5	450-4790	1885
Protein	210-560	350
Fat	35-500	209
Carbohydrate	252-931	522
Nitrogen	15-180	76
Phosphorus	11-160	50
Sodium	60-807	-
Chloride	48-469	276
Calcium	57-112	-
Magnesium	25-49	-
Potassium	11-160	67
	range	**average**
Temperature (^0C)	12-49	24
pH	5.3-9.4	7.1

Source: Jones (1974)

Table 2. Indicative BOD Levels of Milk and Milk Products

Product	BOD_5 in Product (mg/kg)	Wastewater (g/kg milk processed)	BOD_5 in Wastewater (g/kg milk processed)	BOD_5 in Wastewater (mg/L)
Whole milk	104 000	500	0.46	920
Butter	-	1450	2.60	1790
Skim milk	67 000	1100	2.15	1950
Heavy cream	399 000	-	-	-
Buttermilk	68 000	1160	1.85	1590
Yoghurt	91 000	1160	1.89	1630
Icecream*	292 000	1150	2.09	1820
Cheddar cheese	-	770	1.25	1620
Whey (cheese)	34 000	2200#	-	28000

Source: Jones (1974), Lyons et al (1989)

* 15% added sugar, # including whey, BOD_5 (five day BOD)

**Dairy processing wastewater characteristics vary markedly depending on milk load, dilution with washwater, pre-treatment, cleaning compounds and age of plant. The characteristics detailed in Tables 1 and 2 are quite dated and research is under way to revise the tabulated information.

A separate and much more significant problem occurs when a batch of milk or milk product, which may have a BOD concentration 100 times that of the factory wastewater, has to be discarded because of contamination or spoilage. This could be used as animal feed or any other applications not detrimental to the environment. Disposal via the normal effluent treatment system may be allowed provided there is no detrimental effect on the environment.

4 GUIDELINES

The Guidelines which follow are designed to provide general principles for nationally consistent environmental management of dairy processing plants to protect water quality. The principles can be adapted by individual jurisdictions to take account of their own legislative and environmental requirements. They are not intended to provide detailed prescriptive standards.

The important factors in planning, developing and managing dairy processing plants to ensure economic and ecological sustainability are:

- site suitability
- the design of the effluent management system
- effluent treatment
- effluent use
- effluent disposal in circumstances where its use is not practicable
- monitoring and reporting
- contingency measures

4.1 Site suitability assessment

Siting has a significant impact on the complexity and cost of effluent treatment, and the management which would be required to protect water quality. Carefully planned siting of facilities, particularly the effluent utilisation areas facilitates the environmental management of an operation. Where possible, the site selected should be one which avoids the need for costly environmental protection measures and which ensures preservation of community amenity.

Objectives

For existing operations to:

- identify site constraints which can result in adverse environmental impacts
- manage the dairy processing operations through effective use of appropriate practices, techniques and technologies to allow for these constraints
- enhance or maintain the water quality of relevant water resources based on the agreed environmental values for the resources.

For new dairy processing developments to:

- avoid unacceptable environmental impacts on water resources, soils and amenity
- enhance or maintain the water quality of relevant water resources based on the agreed environmental values for the resources.

Guidelines

The following factors should be taken into account when choosing a site.

4.1.1 Existing operations

Existing operations with site constraints (eg. high watertable, particular soil characteristics, and/or topography, presence of incompatible land uses, size of site, availability of services) should consider implementing the following:

- innovative and effective technologies to minimise effluent and allow for its reuse
- effective design of the plant
- effective housekeeping and best management practices

- an effective monitoring system to enable potential problems to be detected early
- replacement of obsolete technology by proven and more cost-effective technology
- liaison with regional planning/zoning authorities.

If the operation cannot overcome the constraints, its scale should be reduced to a manageable level, be re-established in a suitable location, or closed.

4.1.2 New developments

Siting of new operations or substantial expansions to existing operations should consider the following:

- the amount of land required for establishing the enterprise, taking into account:
  - estimation of quality and quantity of the effluent and solid wastes/sludges produced at all stages of the process (ie, raw, post treatment, post storage etc)
  - land suitability (including topography, slope, surface soil type and previous landuse practices)
  - characterisation of the soil to determine its suitability for the storage, treatment and application of effluent and other solid wastes
  - type of effluent storage and treatment system to be used
  - future expansions
- climate (including rainfall, prevailing winds, katabatic wind/ drainage, evaporation)
- type of effluent storage and treatment system to be used
- neighbouring landuse, including residential, commercial, industrial and agricultural
- proximity to sensitive sites, including to surface and groundwaters, areas of scientific value, areas of Aboriginal significance and areas containing unique, uncommon or endangered fauna and flora
- the proximity of services and amenities including water supply
- the need for appropriate buffer zones between the enterprise and sensitive areas including waters and residences
- potential beneficial uses of groundwater
- the requirements of the sewerage service provider for industrial waste disposal, if disposal to sewer is planned for plants in urban areas
- other factors outlined in Section 4.4, Use of Dairy Processing Effluent, eg surface runoff/soil erosion.

Once the site has been chosen, it should be benchmarked to:

- develop siting, operational and management systems that ensure the facility is managed to minimise environmental impact
- compare benchmark information with subsequent monitoring information to assess environmental performance.

Performance assessment options

Performance Indicators for site suitability could include:

Existing sites

- appropriate practices, techniques and technologies have been developed and used on site
- an acceptable Environmental Management System and /or Plan is in place
- public amenity has been maintained by odour control
- a monitoring program is in place for water and odour (for monitoring of water resources, see the NWQMS documents: *Australian Water Quality Guidelines for*

Fresh and Marine Waters, and *Guidelines for Water Quality Monitoring and Reporting).*

New sites

- Best Available Technology has been implemented, where possible at reasonable cost, to ensure environmental protection measures specific to the site have been undertaken.

New and existing sites

- risk management assessment of the site has been undertaken
- assessment has been made of the suitability of the soil and hydrology at the site for a dairy processing plant
- protection measures specific to the site have been established
- adverse impacts on water resources, land and amenity have been minimised
- adequate safeguards for possible system failure are in place.

The proponent's past environmental performance should be considered where approval is to be given for the development of a new dairy processing plant, or for extensions to existing operations.

4.2 Design of the effluent management system

Dairy processing plants should incorporate modern technologies and processes. This involves adopting technology which has consistently achieved the desired effluent quality levels in economically viable operations. It should also take account state-of-the-art engineering and scientific developments in effluent treatment and opportunities for waste minimisation. It is recognised that good effluent quality is not necessarily dependent on sophisticated technology and may often involve simple, innovative solutions.

Objectives

These are to:

- optimise the quantity and quality of effluent, given the expected use of the effluent
- produce effluent of a quality which will enhance its reuse
- meet regulatory requirements
- design an effluent treatment and management system which includes zero discharge to surface waters and aims at zero discharge to groundwaters. It is recognised that a leaching fraction may be needed to flush salts beyond the root zone
- ensure that the various components of the dairy processing plant, including the effluent management and treatment systems, are mutually compatible and well-integrated.

Guidelines

4.2.1 Separating stormwater from dairy processing effluent

Uncontaminated stormwater can be separated from the effluent system and either collected for use within the plant or directed to watercourses to maintain environmental flows. Separating stormwater from the effluent will reduce the volume of effluent generated and improve treatment plant performance. Stormwater does not need to be separated if it is to be used in the operation of the plant.

Contaminated stormwater should be directed to effluent collection ponds, provided the ponds have the capacity to handle the extra volumes that may be involved. If the effluent system cannot handle the volume, then the plant should be designed to allow for the separate collection and containment of contaminated stormwater.

Stormwater, contaminated and uncontaminated, should be minimised by the construction of stormwater diversion systems to minimise runon to site.

4.2.2 Optimising the volume of effluent generated, and enhancing water recycling

The plant should be designed to optimise the overall operation. Efficient use of water, including recycling, will minimise the volumes of effluent generated and the consumption of clean water. This can be achieved by ensuring the plant's various components, including the effluent management systems, are mutually compatible and well-integrated. Use of waste by-products will improve the effluent quality.

4.2.3 Separating the various waste streams

Attention should be given to separating the waste stream components according to their characteristics and specific treatment needs to improve the resultant effluent quality. This should reduce the need for costly treatment and enhance opportunities for utilisation. Separation of the following should be considered:

- solids and liquids
- high and low salinity effluent
- effluent from ion exchange processes.

4.2.4 Effluent treatment systems

The selection of an effluent treatment process will depend mainly on the components of the effluent and their concentrations, available accepted technologies, the desired final quality of the effluent, solid waste/sludge, and cost. The range of available treatment options is discussed in section 4.3.

4.2.5 Effective effluent containment and storage

Effluent management systems will commonly also have to provide storage for the effluents including spoiled milk, until they can be used or arrangements made for their disposal in a manner which will not adversely impact on the environment. Because of potential odour, waste water may have to be applied directly to land within a few hours of production or treated to reduce the strength of the waste.

Storage tanks, and storage and treatment lagoons, should be designed to safely contain their maximum operational load and comply with local regulations. This should take into account the maximum volumes of effluent to be stored during seasons when land application may not be possible, as well as increased effluent volumes resulting from above average rainfall (relevant authorities should be consulted on conditions required to satisfy local requirements). A generally accepted standard is to design any system to cope with the wettest year in ten. Storage systems should also incorporate a spillway to prevent damage during any overtopping under extreme conditions.

The base should be constructed with low permeability materials or lined with such materials to minimise the leakage of effluent to groundwater resources. In addition, lagoons should be designed and constructed to prevent potential pollution of surface water through runoff.

4.2.6 Controlling spillages

Areas where accidental spillage of effluent or products could occur should be adequately bunded or sloped to drains and directed to effluent treatment areas. Effective alarm systems should be installed throughout the plant, particularly in areas where equipment malfunction or spillage of material would cause pollution, to enable accidents to be detected and remedial action instituted.

Chemical spills should also be contained and should not be directed to effluent treatment and storage areas.

4.2.7 Preventing contamination of water supplies

When water supply is from a reticulated source, surface water impoundment or direct from groundwater bores, backflow prevention devices which meet relevant Australian Standards should be installed. Water authorities should be contacted to ascertain any controls on establishing and operating dairy processing plants within declared drinking water source areas.

4.2.8. Land application of effluent

The ultimate aim of any effluent management system is to sustainably use and assimilate the nutrients, salts, organic matter and water contained in the effluent and solids, into the environment by employing crops, pastures and soils. For further details refer to Section 4.4, Use of dairy processing effluent.

4.2.9 Odour control

Odours from the site of the dairy processing plant can occasionally result in the loss of public amenity. These odours arise from poor design and management of the dairy processing plant. Protecting the community from odours depends on several factors, including:

- the quality of effluent discharge
- the type of effluent treatment systems
- methods used to minimise and treat odours generated from effluent treatment, storage and disposal
- whether effective buffer zones have been considered at all stages of the planning process for the operation, including
    - the distance between sites on the property where operations are undertaken and the surrounding amenities
    - physical barriers, including topography and vegetation
    - climatic conditions, including wind direction, speed and turbulence (eg by plume modelling)
- community consultation and involvement.

By themselves, buffer zones do not protect the community from odour. Most odour problems will be alleviated if the effluent management practices recommended elsewhere in these Guidelines are adopted for new and existing dairy processing plants. Proponents, as well as operators of existing dairy processing plants, are encouraged to discuss separation distances for buffer zones and other related requirements, with the relevant State or Territory agencies or authorities and most importantly, the local community.

When new activities are proposed for sites near established dairy processing plants, it is important to recognise the existence of agreed buffer zones.

Performance assessment options

Monitor:

- the volume and characteristics of treated and untreated effluent so that they are kept within sustainable and manageable limits
- quantities of recycled and reused process liquors and effluent

- spillages; ensure they are contained and sources dealt with
- any odours
- effluent and solids application areas, for possible degradation of soil structure, salinisation, waterlogging, chemical contamination or erosion and impacts on groundwater.

Assess the dairy processing plant's overall performance in consultation with the community and relevant government authorities.

4.3 Treatment of dairy processing effluent

Suitable treatment in a properly constructed and maintained treatment system will be required prior to utilisation of the effluent.

Objective

To treat dairy processing effluent to allow for its use in an environmentally sustainable manner for a particular site.

Guidelines

The treatment systems should permit safe, effective and sustainable land application of liquids and separated solids. For disposal to sewer, the treatment should achieve the quality required by the treatment plant for trade waste.

Any treatment system will need to be able to either reduce, or deal with:

- BOD
- total suspended solids
- nutrients
- odour generation potential

Options for the treatment and management of dairy processing effluent are summarised in Figure 3.

While treatment methods will vary between dairy processing plants, methods should be the best available considering:

- the required level of treatment
- cost
- technical capabilities and backup
- ability to handle extreme events, eg shock loadings.

After treatment, the effluent can be applied to the land at a managed rate which ensures long term sustainable application. Any treatment system needs to be carefully managed and regularly maintained. It is important to ensure that the management expertise for efficient effluent treatment is available at all times.

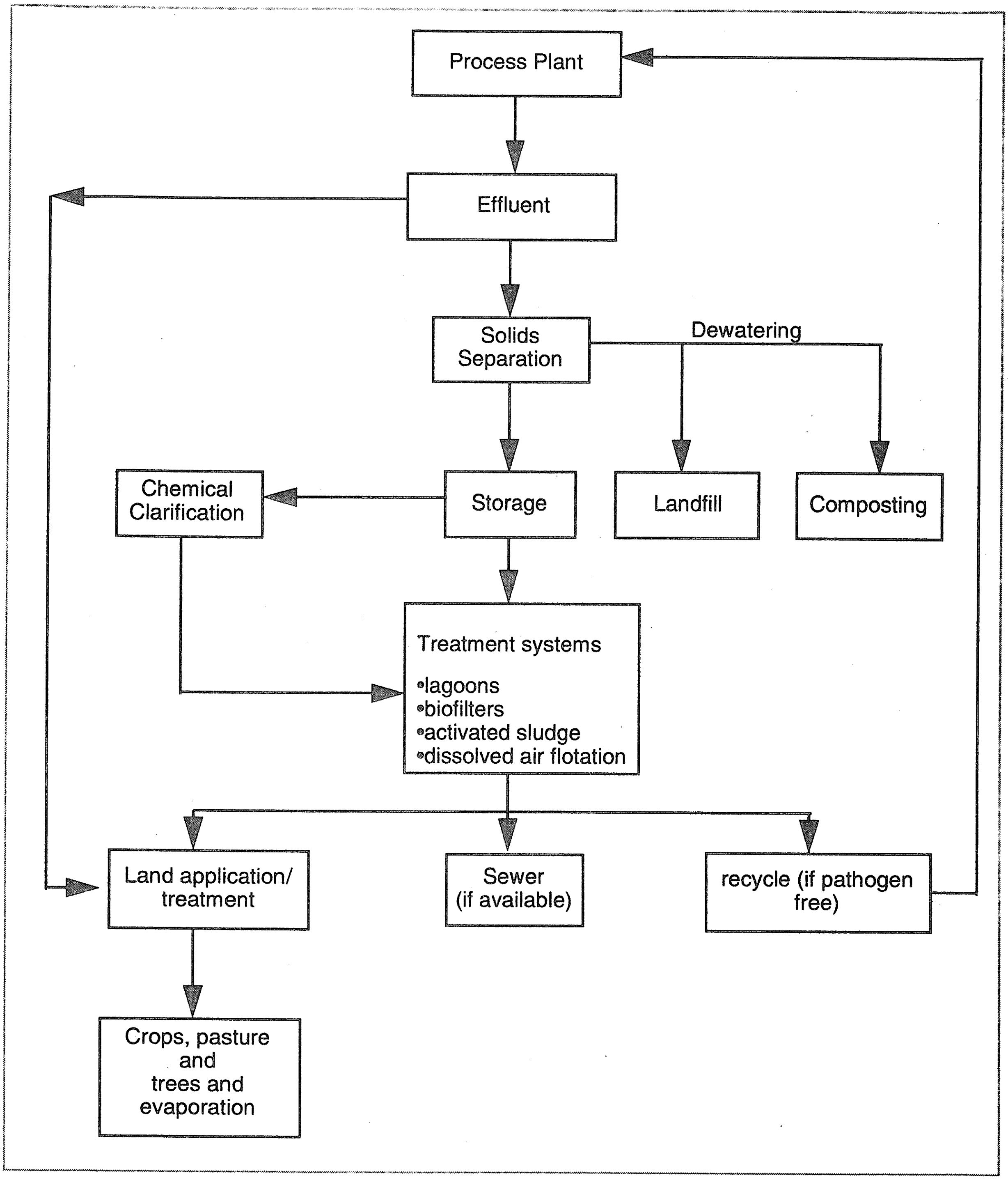

Figure 3: Dairy Processing Effluent Treatment and Use and Discharge Options

4.3.1 Options for treating effluents

The following methods can be used in an appropriate combination to achieve the effluent treatment objectives:

Physical treatment

Solids and suspended matter can be separated from the effluent stream by use of equipment and separation methods such as dissolved air flotation, centrifugation and micro-filtration. This type of treatment will not only reduce the rate of sludge build up in lagoons and wear on pumps, but also should be a rapid way of reducing the BOD concentration in effluent prior to disposal or reuse.

Chemical treatment

Chemicals can be used to enhance treatment characteristics, such as settling of solids by pH correction, and to improve treatment performance or suitability for land application. Care should be taken to ensure that concentrations of any trace elements such as copper or cadmium, which may be present as impurities, do not have adverse residual impact on organisms in the treatment and disposal systems and in the general environment.

Biological treatment

The most common form of biological treatment to enhance the break down of pollutants is anaerobic and/or aerobic lagoons. Lagoon systems should be managed to take account of quantity, quality and intermittent generation of effluents, the likelihood of odours affecting nearby landowners, and the ultimate disposal/reuse method to be adopted.

4.3.2 Guidance on siting and design of treatment lagoons

Lagoon systems are suitable for effluent treatment where topography and soil conditions favour their installation. Some State regulatory authorities may have information on the siting and design of treatment lagoons to prevent surface and groundwater contamination.

Lagoon siting and soils

Lagoons may be installed where the slope of the land is not too steep to cause problems with their construction and where soils are sufficiently impermeable to retain effluents in the lagoon. Impervious liners should be used in lagoon construction where underlying soil permeability is suspect and there is a potential to contaminate groundwater. Great attention must be paid to their installation. Lagoons should not be constructed where overflows can enter surface waters or natural wetlands. They should not be installed across watercourses. Adjacent surface water runoff should be prevented from entering the lagoon.

Lagoon design and sizing

Lagoons should be designed to cater for maximum hydraulic and waste load and to allow for a dairy processing plant's future expansion. Lagoon systems should be large enough to retain the total volume of wastewater where soils may be saturated for a period, as in areas with a prolonged wet season. Allowance needs to be made for primary lagoons to be taken out of service, solar dried and desludged after about 5 - 10 years of service. Allowance should be made for any runoff from the catchment of the lagoon and any contaminated stormwater flows from the plant.

4.3.3 Capacity of the effluent management system

Planning for any increase in dairy processing production needs to consider the capacity of the effluent treatment system. Treatment capacity can be augmented in several different ways, including:

- load reduction due to improved housekeeping and/or effluent stream segregation
- chemical or microbiological supplements
- physical pre-treatment processes
- enhanced aeration of lagoons
- anaerobic pre-treatment processes with appropriate controls on gases generated
- expansion of the lagoon capacity
- new wastewater treatment facilities
- acquisition of more land.

Performance assessment options

These include:

- the characteristics of the effluent are monitored before and after treatment to gauge the effectiveness of any treatment
- dairy processing effluent is used for land application, eg irrigating crops, pastures and trees
- all polluted runoff has been contained
- surface and groundwater is monitored for ambient levels of salt, BOD, nitrogen, phosphorus, potassium, pH, and pathogens (refer to recommended levels for environmental values in *Australian Water Quality Guidelines for Fresh and Marine Waters* as a guide)
- soils are monitored for the effect of effluent application, including physical, chemical and biological characteristics
- the effects on public amenity are evaluated by observing buffer zones and noting any public complaints
- pastures, crops or trees are monitored for yield and foliar symptoms, growth rates and health
- records are maintained from which the history of loading of water, nutrients, salts and contaminants can be calculated for all areas where effluent is applied.

4.4 Use of dairy processing effluent

Objective

To encourage the use of the nutrient, organic matter and water values of the solid waste/sludge and effluents, where this use is not precluded by other components of the effluents such as salts, in a manner which protects water quality consistent with the environmental objectives.

Guidelines

Generally, land application provides the most efficient means of recycling valuable water, along with the effluent's nutrient and organic components. Suitable treatment in a properly constructed and maintained treatment system will be required.

Issues relating to groundwater protection, soil structure, land contamination, salinity and eutrophication of surface waters will need to be carefully considered on a local/regional basis. Local conditions may limit or preclude the application of effluent via irrigation because of the particular sensitivity of the site with respect to these issues. These issues are considered in the following sections.

Further information on the utilisation of treated effluent by irrigation is available from relevant State and Territory Environment authorities including, the Victorian and NSW Environment Protection Authorities (EPA (Victoria) (1992) and EPA - NSW (1995)).

Note that application of the guidelines alone does not assure adequate protection of groundwater quality.

4.4.1 Land requirement

The amount of land required depends on a number of factors including:

- susceptibility to waterlogging, surface runoff and soil erosion
- potential effect on groundwater depth and quality, and surface water
- climatic conditions (rainfall, wind speed, evapotranspiration)

- the nature of pasture or crop grown
- pastoral, agricultural and horticultural practices
- the properties of soils (infiltration rate, phosphorus sorption capacity, moisture storage capacity in the root zone, physical characteristics and other chemical properties including Electrical Conductivity, Sodium Absorption Ratio (see p.21), Exchangeable Sodium Percentage
- the quality and quantity of the effluent
- maximum operational life of the application site, determined by the phosphorus sorption capacity of the site and predicted salt accumulation.

The nature of the soils

Long term application of dairy processing effluent at excessive levels could damage soils. It is important to ensure that the soils have the following characteristics:

- a structure that permits air movement and water penetration
- sufficient depth to permit optimum root development by the crop
- adequate natural drainage or suitable artificial drainage
- sufficient capacity to hold water for plant use between successive irrigations
- nutrients in sufficient quantities for adequate plant growth
- moderate pH ie, it should be neither too acid nor too alkaline
    - neutral to slightly acid soils are best for most irrigated crops
- ease of cultivation.

It is not always possible to have all of these qualities, and the relative importance of each will depend to some extent on the type of crop to be grown, as well as the characteristics of the effluent.

The most satisfactory soils for efficient irrigation are deep, well structured and well drained, ranging in texture from loam to clay loam. They are generally preferred to sandy soils, which are very permeable, and heavy clay soils, although the range of soils that are satisfactory for crop production under irrigation is quite wide. Soils suitable for effluent irrigation are those that are suitable for irrigated pasture or crop production. Soils for solid wastes and sludge application should be suited to improving pasture or dryland cropping, able to withstand cultivation without incurring significant erosion or major structural decline and not prone to water logging.

Soils generally considered unsuitable for irrigation include:

- poorly structured clays
- shallow soils with rock, gravel or impeding clay close to the surface
- soils with poor drainage
- soils with a high salt content and low permeability.

A soil survey is the most satisfactory way of determining the suitability of different soils for the application of effluent to land for pasture and crop production.

Land application rates

Before and during land application, scheduling and application rates based on the properties of the effluent including its salinity and nutrient content, pH and BOD need to be considered. This should be assessed seasonally.

While maximum application rates for land treatment of effluent will depend on site-specific conditions, in general they will be limited by one or more of the following:

- hydraulic loading
- nutrient loading/balance (N, P, K)
- salt loading.

Guidelines which aim to maintain effluent loading at a rate which, after accounting for rainfall, is balanced by evapotranspiration, are inadequate to protect groundwater. This is especially so in areas where rainfall can exceed evapotranspiration over periods which are sufficiently long that excess water (and solutes, such as nitrate and salts) can leach beneath the root zone.

As rainfall cannot be controlled, the only effective way of preventing excessive contamination of groundwater is to ensure that concentrations of nitrogen and salt below the root zone remain at an acceptable level. This may require land application of effluent to be suspended during wet periods or seasons.

A nutrient balance can be developed where the losses from the system are:

- the uptake of nutrients by plants which are removed
- gaseous losses of nitrogen
- net accumulation of nutrients in the soil.

Such balances should be calculated to account for within-season variations in components of the nutrient budget (particularly plant uptake, net mineralisation and leaching) when determining application rates. Long term nutrient monitoring of the soil solution below the root zone would provide feedback on sustainable application rates and site management, and complement groundwater sampling at the watertable.

Water budgets

Water budget studies are an important tool for quantifying land requirements and the volume of effluent which may be applied.

Surface runoff/soil erosion

To minimise surface runoff and soil erosion, effluent should not be used on land which is:

- immediately adjacent to streams and water courses
- subject to flooding (flood risk analysis should be undertaken)
- waterlogged or saline
- sloping with inadequate ground cover
- rocky, slaking and highly erodible
- of highly impermeable soil type.

Irrigation runoff should be contained on site. Irrigating onto areas receiving surface run-off from higher land increases the risk of effluent moving offsite. Protection by diversion banks located upslope of the irrigated area is advisable.

Groundwater

Important factors to consider are:

- groundwater quality
- the depth to groundwater - including perched and seasonal watertables, and soil type - which can influence infiltration rates
- the location, characteristics, and current and potential use of groundwater.

A small increase in infiltration of water from the surface to the groundwater can cause a rise in the level of the watertable. As the watertable rises, it carries the salts in the soil towards the surface, increasing salt levels in the root zone and possibly causing waterlogging. It is unlikely to occur where dairy processing effluent is applied to dryland crops and pastures (in permeable soils with a substantial separation between surface and watertable).

Measures to protect groundwater quality will be more onerous where the ambient groundwater quality is capable of providing drinking water supplies or sustains ecosystems. Once contaminated, groundwater is expensive to clean up.

Hydrogeological expertise will be required to evaluate the characteristics of the groundwater beneath the land application area. This will include evaluation of mixing and dilution, travel times, direction of groundwater flow, and the possibility of denitrification occurring. Consideration may also need to be given to the construction of monitoring wells which can provide valuable information for the design of effluent irrigation.

The NWQMS document *Guidelines for Groundwater Protection* should be consulted when considering groundwater issues.

Surface waters

The following should be taken into account:

- general features - distances of various waterbodies and water uses from proposed dairy processing plant and /or land application site
- hydrological features - catchment area and drainage patterns.

Climatic conditions

Factors include the following, all of which affect evapotranspiration rates and any tendency to flooding or waterlogging:

- regional climate - rainfall, temperatures, humidity, winds, evaporation
- local microclimate - diurnal pressure and associated air movement patterns.

Effluent should only be applied during conditions which will minimise polluted run-off, groundwater contamination or surface ponding.

Agricultural and horticultural practices

The decision to use either crops, trees or pasture, or a combination, and the selection of species, should be based on the other factors discussed in this section.

The vegetation, which has stored nutrients taken up from the effluent, needs to be removed from the site of application to prevent these nutrients being re-released into the soil (by decaying vegetation or as livestock wastes). Leaching of nutrients to groundwater is a particular concern but can be controlled by careful design of effluent irrigation rates and attention to harvesting and removing vegetation from the site of application, for example as fodder or crop. Operators should comply with appropriate health regulations and guidelines concerning human and animal consumption of irrigated crops. Where livestock are used to harvest the vegetation through grazing, the size of the reuse area will need to be increased to accommodate the nutrients returned in their manure.

4.4.2 Characteristics of the effluent

The characterisation of the effluent for a particular enterprise is fundamental to the operation and management of that enterprise and for the adequate assessment for any land application program. Collection of data by operators is encouraged and some or all of the following may be required for initial characterisation and ongoing monitoring:

- total solids
- suspended solids
- BOD
- COD
- organic carbon
- electrical conductivity (EC)
- exchangeable cations (sodium, magnesium, calcium)
- sodium adsorption ratio
- pH
- total kjeldahl nitrogen
- ammonia nitrogen
- phosphorus
- potassium
- sulphate

Concentrations of nutrients, (NPK) total dissolved solids or salinity, organic matter, BOD, and suspended solids (non-filterable residue) should be regularly tested in effluent and solid wastes/sludges. This is particularly important just prior to land application to calculate and determine appropriate application rates.

Biochemical Oxygen Demand (BOD)

Over-application of high BOD effluent can create anaerobic conditions in the soil. Prolonged oxygen depletion will reduce the capability of the soil micro-organisms to breakdown the organic matter in the effluent and may ultimately lead to odour generation and surface and/or groundwater pollution. It is therefore essential to apply effluent at rates that will not cause the development of anaerobic conditions. Also resting periods between applications may be required to permit re-aeration of the soil. However, the quantity of oxygen which can be held in different types of soil varies according to soil texture and structure. State authorities may be able to advise on loading rates which do not cause environmental effects under various climatic conditions.

Total dissolved solids or salinity

The salinity or total dissolved solids (TDS) concentration of irrigation water, measured as electrical conductivity (EC), is an extremely important water quality consideration. An increase in salinity or EC levels causes an increase in the osmotic pressure of the soil solution, and results in reduced availability of water for plant consumption and possible retardation of plant growth.

Recommended guidelines for saline irrigation water are available in the NWQMS document *Australian Water Quality Guidelines for Fresh and Marine Waters.* These guidelines take into account soil characteristics, crop tolerance, climate, and irrigation practices which can influence soil loadings for particular contaminants.

With adequate drainage, salt accumulation in the soil can be controlled to an extent by the application rate of water. If the sum of applied irrigation water and rainfall is lower than evaporation and plant consumption, accumulation of salts in the main root zone will result.

Proper irrigation management will allow application of sufficient excess water (leaching fraction) to move a portion of the salts out of the root zone, whilst not causing excessive increases in the groundwater table. (NWQMS - *Australian Water Quality Guidelines for Fresh and Marine Waters, p 5-7*)

It is important to distinguish between salinity due to sodium chloride from that due to other dissolved solids, some of which may be beneficial to soil.

Salt management plan

A salt management plan that takes into account the issues discussed in the previous section, and which will consequently adequately manage salt in a land application program, should be developed. The decision to apply saline effluent will need to be dealt with on a case by case basis. Unless a detailed salt management plan can be developed to adequately manage the salt in a land application program, alternative methods of reuse/disposal of effluents should be considered.

Sodium Adsorption Ratio (SAR)

Excessive sodium in irrigation water relative to calcium and magnesium can adversely affect soil structure and reduce the rate at which water moves into and through the soil. Problems of soil permeability increase when SAR approaches 10. (*Australian Water Quality Guidelines for Fresh and Marine Waters)*

Where possible application of dairy processing effluent to land with an Sodium Adsorption Ratio greater than 10 should be avoided to minimise the risk of soil waterlogging and destabilising soil structure. The SAR can be expressed as:

$$S.A.R = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

Na = sodium concentration (meq/L)
= (mg/L in effluent) / (22.99)

Ca = calcium concentration (meq/L)
= (mg/L in effluent) / (40.08 x 0.5)

Mg = magnesium concentration (meq/L)
= (mg/L in effluent) / (24.32 x 0.5)

Where effluent with a high SAR poses a problem, consideration could be given to blending it with better quality water. Dilution of effluent streams with high quality water is not recommended practice in areas where water resources are scarce. Evaporative disposal may be an alternative worth considering. Alternating irrigation with high quality water is not recommended unless soil amelioration is also made. Alternating low salinity water after using high salinity water must be monitored to avoid crusting and sealing which can lead to an appreciably reduced infiltration rate. As with all other parameters in the design of a land irrigation system, the actual suitable SAR of the effluent will depend on the soil characteristics of the site. Sodium is required in limited amounts for most plant growth. However, some plants are sodium-sensitive and can be affected by low concentrations of exchangeable sodium. It has been reported that sodium toxicity can occur in sensitive fruit crops when SAR is as low as 5.5 (Bernstien (1962) p 5-6 NWQMS - *Australian Water Quality Guidelines for Fresh and Marine Waters)*

Nutrients

The nutrients in effluent most likely to be utilised by plants are nitrogen, phosphorus and potassium. The availability of these nutrients for plant uptake is spread over a number years. Nitrogen, for example is present as ammonium, ammonia, organic nitrogen, nitrate and nitrite, however plants only take up nitrogen in the ammonium and nitrate forms. The other forms can become available through the processes of the nitrogen cycle so that for example the organic nitrogen (proteins) is slowly mineralised into plant available forms over a number of years. Phosphorus is also released for plant uptake over time although some of it is quickly bound up by the soil and not available for plant use.

Optimum use of nutrients will depend on soil type, moisture availability, crop type and land management.

4.4.3 Irrigation Management

An irrigation management plan should be developed detailing the following:

- irrigation methods
- crop, water and nutrient requirements
- application rates
- scheduling
- design for the collection
- storage
- utilisation and management of stormwater and tailwater
- a salt management plan.

The intensity and depth of irrigation should be adapted to the soil and vegetation to prevent excessive leaching of effluent beneath the root zone. This can be determined by appropriate monitoring of soil moisture and salinity profiles.

Caution should be exercised when spraying effluent as it may contain micro-organisms and pathogens and can drift from the site. Aerosols from spraying should be contained on site and surrounded by a non-irrigated vegetation buffer zone. Local authorities should be consulted when determining the size of the buffer zone. Operators should take care that they do not inhale aerosols, and should comply with appropriate health regulations and guidelines concerning human and animal consumption of irrigated crops.
An irrigation system should take into account the drainage characteristics of the soils. Better drained soils would enable removal of salt and prevent long-term accumulation around the root zones.
Applications should be scheduled, based on a water deficit. When the soil is saturated in periods where rainfall exceeds evaporation, irrigation waters will need to be stored until the soil is suitable for irrigation.

Adequate storage will be required to retain effluent during wet periods or seasons. A generally accepted standard is to design any system to cope with the wettest year in ten. Hydrological expertise should be engaged to design this capacity and to provide guidance on local constraints on effluent irrigation.

Other nutrient-intensive activities incompatible with environmental objectives (such as animal holding) should be excluded from irrigated areas.

It is important that properly trained personnel are available on site to manage the irrigation.

Control of stormwater and irrigation tailwater

Upslope stormwater should be diverted to prevent it from entering the solid and effluent utilisation areas. The use of earth bunds and contour drains to direct runoff from irrigated areas to storage and recovery dams for re-use should be considered, particularly in areas with long dry summers. Runoff from the solid waste/sludge and effluent utilisation areas should be managed to minimise discharge to waters by the use of buffers zones, wetland, terminal ponds etc.

Wastewater irrigation may yield a tailwater discharge which will ultimately need to be disposed of in an environmentally sensitive way. Management of tailwater must be a key consideration of every wastewater irrigation project, as it is often this issue which provides a major impediment to the sustainability of wastewater irrigation.

Performance assessment options

These include:

- dairy processing effluent is used for land application, eg irrigating crops, pastures and trees.
- all polluted runoff has been contained
- surface and groundwater is monitored for ambient levels of salt, nitrogen, phosphorus and pathogens
- soils are monitored for the effect of effluent application, including physical, chemical and biological characteristics
- the effects on public amenity are evaluated by observing buffer zones and noting any public complaints
- crops, trees and pasture yield and foliar symptoms, growth rates and health are monitored
- records are maintained from which the history of loading of water nutrients, salts and contaminants can be calculated for all areas where effluent is applied.

4.5 Use of solid wastes/by-product from dairy processing stream

Objective

To make effective and environmentally sound use of solid dairy processing wastes.

Guideline

Where feasible, unwanted solids such as milk powder, cheese, and butter should be reprocessed for animal feed.

Performance assessment option

Measure the output of solid waste from the dairy processing and record amounts being used.

4.6 Use of treatment derived-sludges

Objective

To make effective and environmentally beneficial use of dairy processing sludge.

Guidelines

Lagoon sludges

Lagoon sludges can be used as a stable, high strength fertiliser. They should be stored to prevent leaching to susceptible groundwaters, with exudate being directed to the effluent system. Lagoons should be de-sludged once the sludge takes up one third of total volume (or half depth) of the lagoon. Sufficient sludge should be retained in the lagoon to enable its activity to be regained quickly upon recommissioning. Professional advice should be sought on removal from the lagoons and application rates (based on tests of that particular sludge). Storage areas for solids should be bunded and have adequate drainage back to the pond system.

Dissolved Air Flotation (DAF) sludges

DAF sludges are comparatively more liquid than lagoon sludges although they have a higher fat content. They are useful for land spreading, particularly given there is little risk from pathogens.

Maximum application rates for land treatment of sludge and solid waste will depend on site-specific conditions. The effect of the application of sludges to land needs to be considered in the Environmental Management Plan. As for dairy processing effluents, the issues discussed in Section 4.4 of this document should be taken into consideration when applying solid wastes and sludges to land.

Performance assessment options

These include:

- solids are being handled and utilised in an effective and environmentally acceptable manner
- the output of sludge from the dairy processing plant is measured and amounts being used are recorded.

4.7 Alternative options for dairy processing effluent

Objective

To dispose of dairy processing effluent in an environmentally acceptable manner, only when effective use of the effluent is not feasible.

Guidelines

No effluent should be discharged to surface or groundwaters unless it can be demonstrated that it is consistent with the integrated catchment management strategy of the area, and the relevant guidelines of the licensing agency. Ambient water quality immediately downstream of the dairy processing plant should remain comfortably within the environmental value attributed to the receiving water body. This may require tertiary treatment (viz nutrient removal, filtration and disinfection) of the effluent prior to discharge. Environmental values of water and the related ambient water quality parameters are described in the NWQMS document *Australian Water Quality Guidelines for Fresh and Marine Waters* which provides further information on this topic.

Where salinity is a problem, highly saline effluents should be separated where possible and directed to evaporating basins for collection of the salts. In some jurisdictions, particularly in inland areas, disposal of salt to landfills may be rejected. Alternative, secure landfills will need to be found. Treated effluents may be discharged to sewer (where applicable), provided the effluents meet the local sewerage service provider's criteria. Salinity is a major concern especially as sewerage authorities are considering water reuse as part of waste minimisation. Additional information on the management of industrial effluent is contained in the NWQMS document *Sewerage Systems - Acceptance of Trade Waste.*

Performance assessment options

These include:

- the effluent quality of any discharge is monitored
- the environmental values of relevant water bodies are monitored
- if discharge to sewer is permitted, the requirements of the relevant authority are monitored to ensure they are being achieved

- compliance with both a regional catchment plan and the relevant guidelines of the licensing agency or agriculture department regarding effluent disposal, including by sewer
- regular assessment of soil condition, surface water, groundwater and odour
- minimisation of unacceptable off-site impacts on water, land, air or vegetation.

4.8 Monitoring and reporting

Monitoring is an essential part of any Environmental Management System and/or Plan. The extent of monitoring required should be determined on the basis of dairy processing plant and property size, and the environmental sensitivity of the location. Monitoring of effluent quality and volumes discharged at land treatment areas is needed to effectively manage an effluent land treatment system. Monitoring of groundwater levels and quality, and soil water concentrations below rooting depths is essential.

Objectives

- To ensure the on-going efficient operation of the plant and performance measurement against the Environmental Management System and Plan.
- To ensure that the plant is meeting its regulatory requirements.

Guidelines

- Monitor effluent quantity and quality
- Include monitoring and reporting on the performance of the effluent as an integral part of the operation's Environmental Management System.
- Maintain records of monitoring data to be made available for review by relevant authorities on request.
- Review procedures and data periodically with regulatory authorities to ascertain the data's usefulness and to effectively monitor performance.
- Develop a Quality Assurance system and use accredited procedures and laboratories to analyse samples to ensure the integrity of monitoring data (eg NATA accredited).
- Conduct regular inspections of facilities, in particular pumps and waste storage reservoirs.
- Undertake regular monitoring of land to which effluent has been applied. The soil should be monitored for nutrient levels, particularly: available phosphorus, total kjeldahl nitrogen, nitrate and ammonium as well as salt levels. Visual assessment should be made for waterlogging, sealing, erosion etc. Harvested crops should also be sampled and analysed to monitor nutrient removal from the site.
- Maintain records of each effluent irrigation area as separate management units including effluent volumes, dates of application, and any pasture/crop management information (eg bales of hay cut and removed).
- Regularly monitor surface waters liable to be affected by a dairy processing plant. Groundwater may be monitored depending on the sensitivity of the site to groundwater.
- Supplement regular reporting with "exception" reporting to alert supervisors to unusual variations in plant performance .
- Pollution events should be reported to relevant regulatory authorities.
- Provide managers with up-to-date information on their plant's environmental performance to enable problems to be detected early and remedial action implemented.
- Provide operators with adequate education and training, particularly in total quality management procedures, and risk management techniques, to assist in ensuring compliance with environmental regulations and requirements.
- Analysis of certain characteristics of the effluent may be required for initial characterisation and ongoing monitoring

Relevant State/Territory and/or local authorities may require occasional or regular reporting depending on the site sensitivity or license arrangements. Establishments with a history of consistently poor environmental performance may be required to submit reports on their environmental performance more frequently.

Performance assessment options

These include:

- a culture toward resource conservation is developed within the factory
- adequate operational planning, consultation, recording, monitoring, reporting, and education and training of staff are in place
- consistent adherence to licence conditions
- no environment related complaints
- regular reporting to management and staff, including feedback on performance, changes to the system, and an internal audit system with relevant documentation and reporting.

4.9 Contingency measures

Objective

As part of a good overall strategic plan for the plant, to have in place effective procedures enabling plant managers to respond effectively to all emergencies and contingencies.

Guidelines

Plants should be prepared for:

- disruption to power supplies which may affect the effluent management system
- human error
- disruption to dairy processing operation or effluent treatment by storms, flooding, fire, etc
- plant breakdowns, including drain blockages, pump failures, or disruption of power supplies
- disposal of waste or contaminated milk or product
- overloading of aerobic or anaerobic treatment plants or lagoons, or unusually low effluent inputs which can affect the system's biological treatment activity
- accidental discharge of hazardous materials into the effluent stream
- changes in the physico-chemical environment which can disrupt the effectiveness of the treatment system's biological activity
- temporary or permanent loss of access to effluent application and disposal facilities
- temporary or permanent loss of trained operators. All managers and staff should be aware of the plan and their individual responsibilities during emergencies. The plan should be regularly rehearsed and updated
- potential leakage from lagoons

Performance assessment options

- A contingency plan including a readily accessible and updated list of emergency contacts is drawn-up, up-to-date and being regularly inspected and trialed.
- Record and regularly analyse the operations response to specific contingencies which have arisen.

APPENDICES

Appendix A: The National Water Quality Management Strategy (NWQMS)

The Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) are working together to develop a National Water Quality Management Strategy (NWQMS).

The guiding principles for the National Water Quality Management Strategy are set out in *Policies and Principles - A Reference Document*, which emphasises the importance of:

- ecologically sustainable development
- integrated (or total) catchment management
- best management practices, including the use of acceptable modern technology, and waste minimisation and use
- the role of economic measures, including user pays and polluter pays.

The process of implementation of the National Water Quality Management Strategy involves the community working in concert with government in setting and achieving local environmental values, which are designed to maintain good water quality and to progressively improve poor water quality. It involves development of a plan for each catchment and aquifer, which takes account of all existing and proposed activities and developments, and which contains the agreed environmental values and feasible management options.

Figure A1 outlines principles, the process and outcomes of the NWQMS.

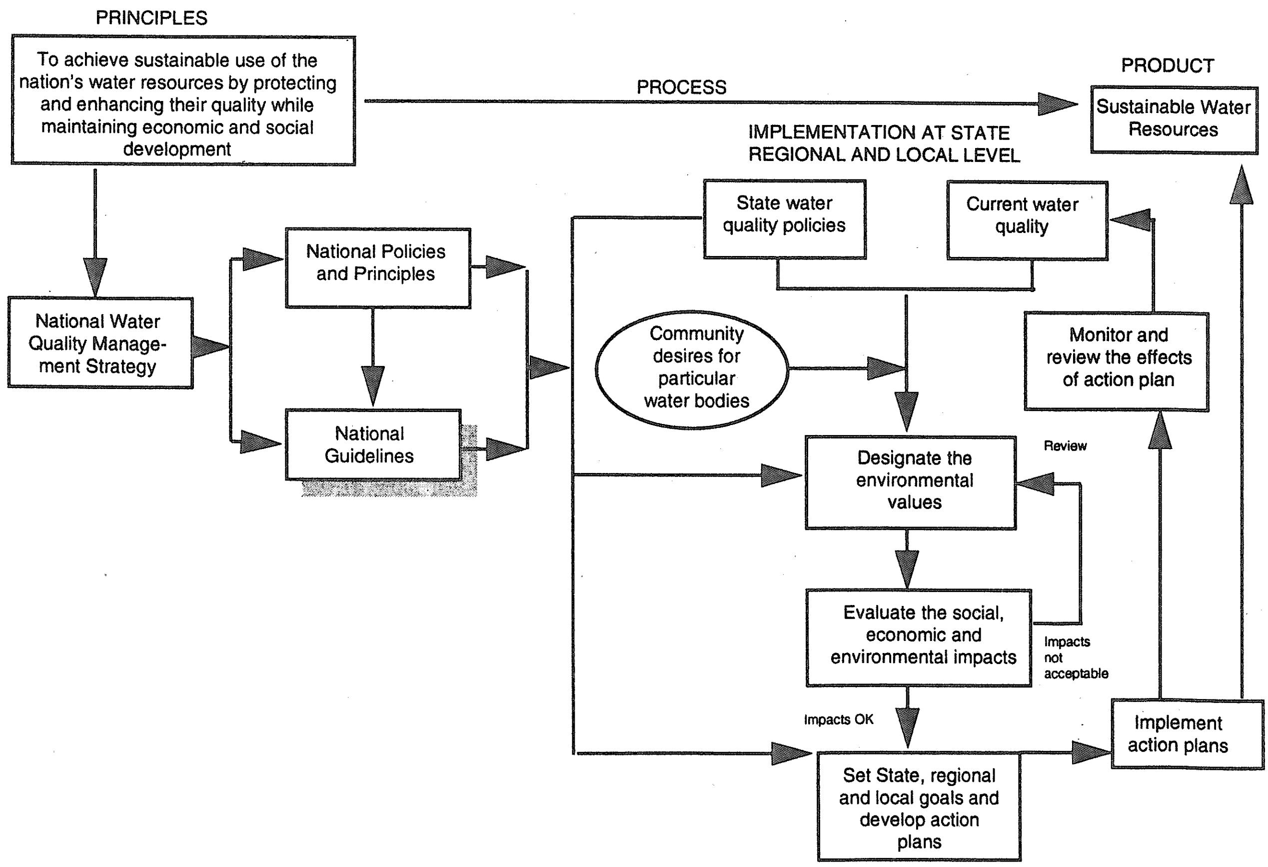

Figure A1: National Water Quality Management Strategy

BOX 1 DOCUMENTS OF THE NATIONAL WATER QUALITY MANAGEMENT STRATEGY

Paper No.	Title
Policies and Process for Water Quality Management	
1	Water Quality Management - An Outline of the Policies
2	Policies and Principles - A Reference Document
3	Implementation Guidelines
Water Quality Benchmarks	
4	Australian Water Quality Guidelines for Fresh and Marine Waters
5	Australian Drinking Water Guidelines - Summary
6	Australian Drinking Water Guidelines
7	Guidelines for Water Quality Monitoring and Reporting
Groundwater Management	
8	Guidelines for Groundwater Protection
Guidelines for Diffuse and Point Sources	
9.	Rural Land Uses and Water Quality
10.	Guidelines for Urban Stormwater Management
11.	Guidelines for Sewerage Systems - Effluent Management
12.	Guidelines for Sewerage Systems - Acceptance of Trade Waste (Industrial Waste)
13.	Guidelines for Sewerage Systems - Sludge (Biosolids) Management
14.	Guidelines for Sewerage Systems - Use of Reclaimed Water
15.	Guidelines for Sewerage Systems - Sewerage System Overflows
16a	Effluent Management Guidelines for Dairy Sheds in Australia
16b	Effluent Management Guidelines for Dairy Processing Plants in Australia
17.	Effluent Management Guidelines for Intensive Piggeries in Australia
18.	Effluent Management Guidelines for Aqueous Wool Scouring and Carbonising in Australia
19.	Effluent Management Guidelines for Tanning and Related Industries in Australia
20.	Effluent Management Guidelines for Australian Wineries and Distilleries

The guidelines for diffuse and point sources are national guidelines which aim to ensure high levels of environmental protection that are broadly consistent across Australia.

Appendix B: Outline of the dairy industry

The dairy industry is a vibrant growing industry which operates in all States, providing milk and manufactured products of the highest quality at world competitive prices.

During 1995-96 Australian production of butter reached 141,000 tonnes, of which about 50 per cent was exported. Total production of milk powder was 338,000 tonnes. The main markets for milk powders are exports and food uses such as icecream, yoghurt, confectionery, bakery lines, and stock feed.

Australia's cheese production in 1995-96 reached 260,000 tonnes. The domestic market for cheese in 1994-95 reached 174,000 tonnes, which included 28,000 tonnes for imports. Production of yoghurt and dairy desserts grew rapidly in the latter half of the 1980s. Yoghurt production in 1994-95 was 93,000 tonnes while icecream production totalled just under 203 million litres in 1993-94.

Appendix C: Sources of further advice

State and Territory Environment Protection Authorities

State and Territory Environment Departments of Agriculture and Primary Industries

State and Territory Environment Departments of Conservation and Land Management

State and Territory Water Authorities

The CSIRO Division of Water Resources (DWR)

Local Government Authorities

Regional Colleges

Industry Consultants

Appendix D: Further information

Further reading

(The NWQMS documents listed in Appendix A should also be consulted)

Department of Primary Industry, Department of Environment and Land Management, Engineering and Water Supply Department, et al, (1993),*Guidelines for the management of milking shed wastewater and intensive stock use areas on dairy farms in the Mount Lofty Ranges*.

Dunford, P & Rose, K (1991):*Dairy effluent treatment and disposal.* In: Effluent control on Dairy Farms, Tasmanian Department of Primary Industry, pp. 13-22.

Environment Protection Authority NSW (1995), *The Utilisation of Treated Effluent by Irrigation (draft).*

Environment Protection Authority (Victoria) (1992), Guidelines for Wastewater Irrigation, EPA Publication no 168.

Gilpin A 1990, *An Australian Dictionary of Environment and Planning* Oxford University Press Australia.

Hubble, I (1991):*Dairy effluent - How much, what's in it and what value?* In: Effluent control on Dairy Farms, Tasmanian Department of Primary Industry, pp. 5-6.

Lyons, B J, Wong, L P & Skerry, G P (1989): *Anaerobic treatment of dairy wastes.* Australian Water and Wastewater Association, 13th Federal Convention, Canberra 6-10 March 1989

Murray-Darling Basin Ministerial Council 1989, *Salinity and Drainage Strategy,* April 1989 AGPS, Canberra

Standards Australia 1995, *Environmental management systems - Specification with guidance for use.* Interim Australian/New Zealand Standard AS/NZ ISO 14001 (Int):1995, Standards Australia, Sydney

Standards Australia 1995, *Environmental management systems - General guidelines on principles, systems and supporting techniques.* Interim Australian/New Zealand Standard AS/NZ ISO 14004 (Int):1995, Standards Australia, Sydney

Wright, D & Bell, I (1991): *Land application of dairy effluent.* In: Effluent control on Dairy Farms, Tasmanian Department of Primary Industry, pp. 7-9..

Wrigley, R (1994): *Managing dairy-shed wastes.* Dairy Research and Development Corporation.

Appendix E: Glossary

Aerobic	a process where dissolved or free oxygen is present.
Anaerobic	a process or condition where there is no dissolved or free oxygen.
Aquifer	a layer of rock which holds water and allows water to percolate through it.
Biochemical Oxygen Demand (BOD)	the amount of oxygen required by aerobic organisms to carry out oxidative metabolism in water containing organic matter. It is determined by measuring the amount of oxygen gas absorbed during a particular laboratory analytical test (BOD test), in which components of a water sample are broken down by aerobic micro-organisms under specified conditions during a stated number of days. BOD_5 denotes a 5-day BOD.
Catchment area	a natural drainage area, especially of a reservoir or river.
Chemical Oxygen Demand (COD)	a measure of the quantity of oxidisable (combinable with oxygen) components present in water. It is determined by measuring the amount of oxygen gas absorbed during a particular laboratory analytical test (COD test), in which components of a water sample are broken down by an inorganic chemical (an oxidising agent) under specified conditions during a certain number of hours.
Denitrification	removal of nitrogen.
Effluent	is used here to refer to the liquid and associated solid waste produced at all stages in dairy processing plants. It does not include runoff from pastures or crops which have been irrigated with dairy effluent.
Electrical conductivity	measure of salinity in water.
Environmental Management System	provides the management, administrative and monitoring framework which ensures that an organisations environmental risk is minimised and that its environmental policy together with associated objectives and targets are achieved. Stages in an EMS, based on the ISO 14000 series comprise commitment to a policy, planning which includes evaluation of relevant regulatory framework, setting objectives and targets, establishing a management program (EMP), definition of personnel and responsibilities, identifying training needs, establishing and maintaining EMS documentation, emergency and preparedness and

response procedures and establishing operational controls, and carrying out audits and reviews including monitoring and review.

Environmental values	particular values or uses of the environment that are conducive to public benefit, welfare, safety or health and that require protection from the effects of pollution, waste discharges and deposits. They are often called beneficial uses in the water quality literature. Five environmental values are: • agricultural water • drinking water • ecosystem protection • industrial water • recreation and aesthetics Refer to the NWQMS documents *Policies and Principles - A Reference Document*, and *Australian Water Quality Guidelines for Fresh and Marine Waters*.
Evapotranspiration	Water lost from soil by evaporation and/or plant transpiration.
Exchangeable Sodium Percentage (ESP)	the amount of exchangeable sodium as a percentage of the cation exchange capacity. It is a measure of the sodicity of the soil. Sodicity relates to the likely dispersion on wetting and shrink/swell properties.
Groundwater recharge	the rate at which infiltrating water reaches the water table.
Guideline	provides guidance on possible means of meeting desired environmental outcomes. Guidelines are not mandatory.
Hydraulic loading	volume of water applied to an area of land.
Infiltration rate	rate of entry of water into the soil.
Katabatic drainage/wind	a wind caused by cold air flowing downhill. When a sloping land surface cools by night time radiation, the cold air in contact with the ground flows downhill and along the valley bottom.
Leaching	the downward movement of a material in solution through soil.
Leaching fraction	The leaching fraction of soils refers to the ratio of deep drainage to the depth of rainfall plus irrigation over the same time period. The smaller the leaching fraction, the larger the water salt concentration within the root zone, or the higher the salt concentration experienced by plant roots.

Perched watertable	upper surface of a zone of saturation where an impermeable stratum causes groundwater to accumulate above it over a limited lateral extent. It is situated above the main watertable.
Phosphate sorption capacity	a measure of the inherent ability of soil particles to adsorb phosphorus from the soil solution.
Risk management	is a decision-making process that entails considerations of political, social, economic and engineering information together with risk-related information to develop, analyse and compare regulatory options and to select the appropriate regulatory response to a potential health or environmental hazard. The entire risk management process consists of eight steps. These are hazard identification, exposure assessment, effects assessment, risk characterisation, risk classification, risk benefit analysis, risk reduction, monitoring.
Standard	a standard is a quantifiable characteristic of the environment against which environmental quality is assessed. Standards are mandatory.
Suspended solids (SS)	matter in waste water that is in suspension.
Tailwater	runoff from irrigation areas which contains nutrients and salts. Also first flush rainfall runoff from land used for wastewater disposal.
Total dissolved solids (TDS)	the amount of dissolved solids in waste water.
Total kjeldahl nitrogen (TKN)	is a determination of organic nitrogen and ammonia
Total solids (TS)	the sum of dissolved and undissolved solids in water or waste water, usually expressed in milligrams per litre.
Total suspended solids (TSS)	the amount of volatile and fixed suspended solids in waste water.
Total volatile solids (TVS)	the organic matter in waste, comprising both suspended and dissolved solids.
Volatile suspended solids (VSS)	the difference between total volatile solids and volatile dissolved solids.
Watertable	the level below which the pore space between sediments and fractures in rock are saturated with water. In an unconfined aquifer, the watertable is the level of the water standing in a well.