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**ENVIRONMENTAL GUIDELINES FOR THE
DAIRY PROCESSING INDUSTRY**

Environment Protection Authority
State Government of Victoria

June 1997

ENVIRONMENTAL GUIDELINES FOR THE DAIRY PROCESSING INDUSTRY

Published under the provisions of section 13(1) of the *Environment Protection Act 1970*

Environment Protection Authority
Olderfleet Buildings
477 Collins Street
Melbourne Victoria 3000
Australia

Printed on recycled paper

Publication 570

© Environment Protection Authority, June 1997

ISBN 0 7306 7525 4

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FOREWORD

EPA has a responsibility to ensure that the environment and the health of the community are protected – both now and for future generations. EPA is seeking improved ways to meet this responsibility.

The proper management of dairy wastes is essential to achieve that objective. As the dairy industry has become more environmental aware and committed to producing good environmental outcomes, alternative mechanisms – such as this guideline – have been developed in line with the Government's desire to promote best practice environmental management (BPEM).

Environmentally-aware dairy companies seeking a better environment and competitive advantage should find merit in this approach. BPEM of dairy emissions will also achieve benefits for the community in terms of sustainable improvements in environment quality.

The BPEM approach seeks to promote innovative uses of waste products by focusing on desired objectives and outcomes rather than regulatory control. In this way, innovation is not stifled and flexibility is provided – but those seeking greater direction or certainty can simply apply the suggested measures.

These guidelines will be reviewed regularly and updated as necessary, on the basis of operating experience and the development of national standards. Users of the guidelines are encouraged to provide comment to assist this process.

I urge the dairy industry and community to consider the benefits of these guidelines.

BRIAN ROBINSON

CHAIRMAN

Acknowledgment

These guidelines were prepared under contract by CMPS&F Environmental in association with the Gilbert Chandler Institute VCAH from original material written by Mr W Regan.

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EXECUTIVE SUMMARY

BACKGROUND

In Victoria, dairy related activities are a major contributor to the State's economy: Victoria generates nearly two-thirds of Australia's milk volume, is responsible for more than 80% of Australia's processed dairy products and 90% of dairy exports.

Plant expansions, site rationalisations and, to some extent, good returns, have contributed to a marked increase in the throughput of most dairy processing factories. The increase in milk production means that processing sites must run harder and longer, particularly during seasonal peaks.

Many sites now operate at or well above their design capacity, with a consequent increase in the impact on the environment from washwater/product separation, wastewater treatment, disposal and air emission control systems.

These Best Practice Environmental Management (BPEM) guidelines have been developed in conjunction with the dairy processing industry to help the industry address its environmental obligations more effectively.

OBJECTIVES OF ENVIRONMENTAL PERFORMANCE

Dairy processing plants should be designed, built and operated to achieve:

- maximum recovery of products such as milk fat and solids
- minimisation of losses or emissions to the environment
- recycling and/or reuse of wastes
- prevention of further environmental degradation
- restoration of the environment
- appropriate location of the plant to minimise the impact on residents, while still allowing for future expansion

- waste management, to avoid degradation of the community environment.

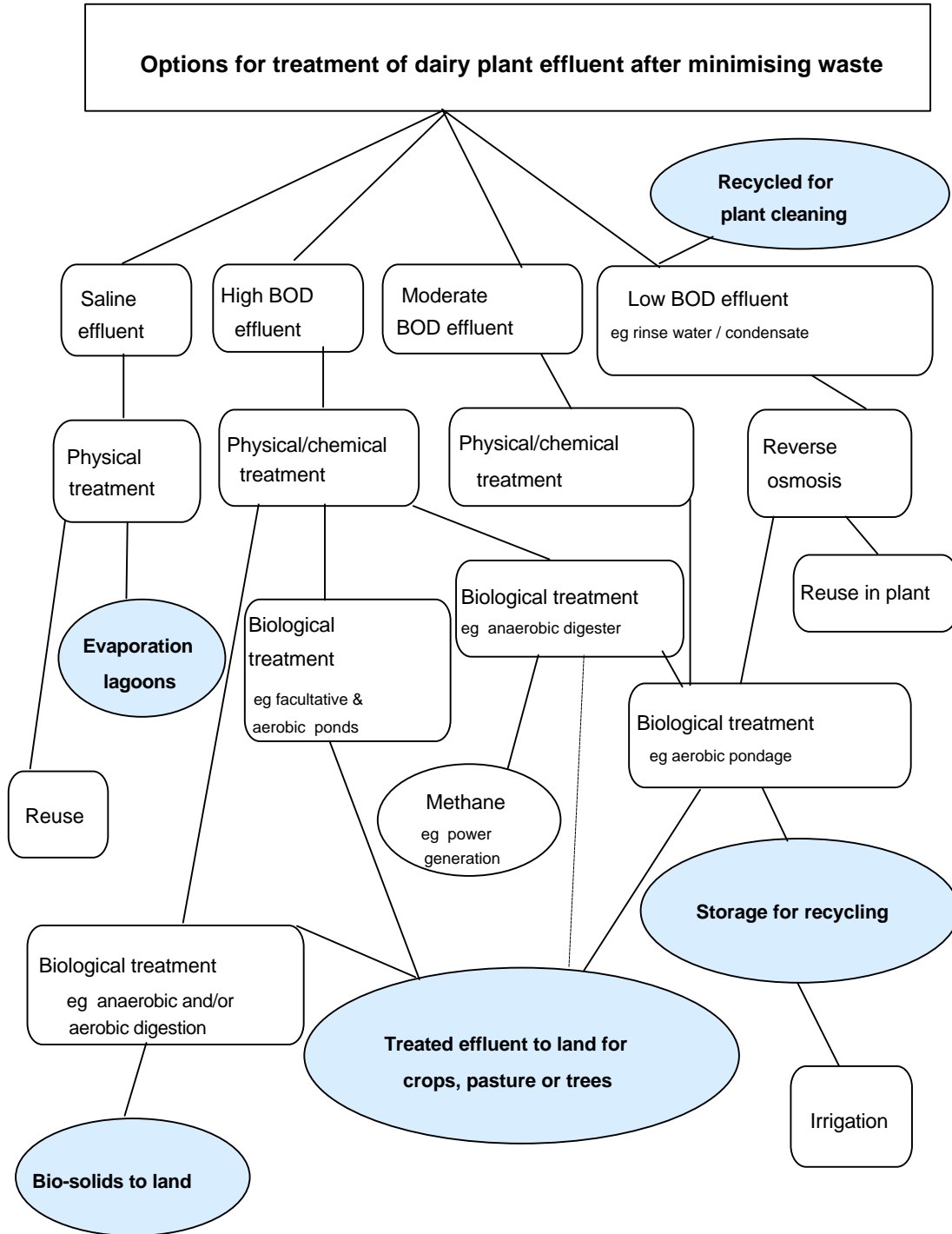
The maximisation of production and the minimisation of emissions are complementary objectives which are crucial to any sustained effort to maximise profitability and minimise waste on any dairy processing site – no matter how large or small.

EPA encourages the industry to adopt cleaner production and waste minimisation principles. BPEM is an approach that positively integrates environmental performance with the long term competitiveness of the industry.

BEST PRACTICE ENVIRONMENTAL MANAGEMENT

The key to BPEM is adopting work practices that will improve operational competitiveness and environmental performance at the same time. BPEM links environmental and operational management positively, with the primary responsibility remaining in industry's hands.

These guidelines promote BPEM by providing, where appropriate, specific criteria and performance measurements which may be adapted to local conditions. The guidelines are outcome oriented and are not intended to be directive, definitive or exhaustive.



Best practice effluent management

1. INTRODUCTION

1.1 INDUSTRY IMPACTS

Victoria is the major Australian producer of milk (5.1 billion litres in 1993/94)¹ and processed dairy products. The dairy industry has high losses ranging from 2% to 3% volume of milk intake (80 to 130 megalitres annually). Depending on the particular site configuration and the waste minimisation processes employed, the volume of wastewater generated during dairy processing may be as high as 2¹/₂ litres of wastewater per litre of milk processed. (World's best practice is 0.5 litres of wastewater per litre of milk processed.)

Poorly treated wastewater with high levels of pollutants – caused by poor design, operation or treatment systems – creates major environmental problems when discharged to surface water or land. Such problems include:

- contamination and deoxygenation of streams and waterways by direct discharge or run-off of inadequately treated wastewater
- excessive concentration of nutrients such as nitrogen and phosphorus in surface and subsurface waters (this contributes to excessive growth of plants and algae blooms which makes downstream water unsuitable for domestic, agricultural and industrial uses)
- land degradation and damage to pastures and crops – long-term damage to soil productivity may arise from:
 - ◆ excessive nutrient loading
 - ◆ high salinity
 - ◆ low/high pH
 - ◆ over-application of wastewater to land, resulting in contaminated groundwater
 - ◆ soil structure decline due to wastewater with high sodium adsorption ratio
 - ◆ poor irrigation design

- ◆ clogging of soils by fats/solids from irrigated wastewater (this may lead to restricted infiltration that will promote pooling and subsequent odour. If wastewater supply exceeds the soil's evaporation and infiltration capacity, the problems increase).

Offensive odours from wastewater being stored or treated are often a problem – particularly with such strong wastes as whey. Extended storage periods are more likely in the cooler months when irrigation is not practicable.

Water and land or reuse systems should be monitored regularly because of the high chance of detrimental environmental effects. The monitoring should be followed by performance assessment and remedial action if necessary.

1.2 STATUTORY REQUIREMENTS

The size of the dairy industry and the volume and nature of the waste generated has a potentially adverse effect on the environment.

The *Environment Protection Act 1970* applies to the operations of the dairy industry and it is essential that all levels of dairy industry management understand the details of their obligations.

To help with this, EPA publishes information bulletins that, together with other relevant literature, are available from EPA Customer Service and Information Centre, Olderfleet Buildings, 477 Collins Street, Melbourne Victoria 3000, telephone (03) 9628 5622.

Environmental policy and guidelines

Waste management and reuse facilities must comply with the relevant environmental policies including those listed below.

- *State Environment Protection Policy (The Air Environment)*, which specifies the objectives for specific gaseous components and particulate emissions.

¹ Victorian Dairy Industry Authority Annual Report 1995

- *State Environment Protection Policy (Waters of Victoria)* – Schedule E lists emission limits for waste discharges to water. More stringent requirements may be necessary with environmental sensitive water areas.
- *State Environment Protection Policy (Waters of Victoria)* – clause 22 requires that waste be discharged preferably to land where practical and environmental beneficial.
- Wastewater disposal facilities should be designed in accordance with *Guidelines for Wastewater Irrigation* (EPA Publication 168). In particular, wastewater storage and disposal should be designed and built to contain all waste in at least 90% of wet years. People and organisations that use land irrigation should ensure that there is enough land area for both present and future wastewater disposal.
- *State Environment Protection Policy (Waters of Victoria)* – clause 23 refers to minimisation of waste generation.
- *State Environment Protection Policy (Groundwaters of Victoria)* (draft 1994) requires that groundwater is protected from activities potentially detrimental to its quality, as well as from hydrogeological testing and assessment.
- *State Environment Protection Policy (Industrial and Commercial Noise NI)*.
- *Industrial Waste Management Policy (Waste Minimisation) 1990* requires all premises subject to works approval to have comprehensive waste management plans – covering all aspects of waste minimisation and identifying options for waste minimisation, the handling, storage and disposal of wastes. These plans are to be prepared in accordance with EPA guidelines.

1.3 OBJECTIVES

The aim of these guidelines is to provide the Dairy Industry with:

- a clear statement of environmental objectives for each segment of the environment affected
- methods to assess and minimise the actual or likely impacts of the dairy industry and

- on the basis of available experience, an outline of BPEM practices to achieve the desired results.

Dairy products and resulting wastes and emissions are summarised in Figure 1.

A checklist is provided in Appendix 2 to enable managers of dairy plants to check that all relevant environmental issues have been addressed in accordance with the guidelines.

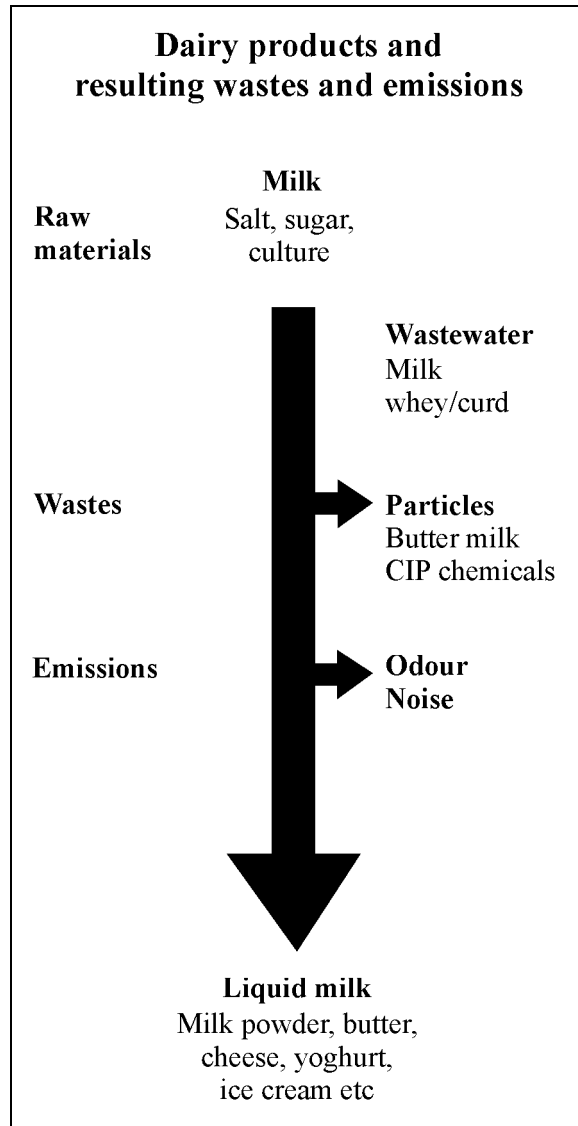


Figure 1 – Dairy wastes and emissions

2. CLEANER PRODUCTION

2.1 WASTE MINIMISATION

Under the *Industrial Waste Management Policy (Waste Minimisation) 1990*, premises which are subject to works approval require waste management plans incorporating waste minimisation. Each dairy plant should therefore assess opportunities for reducing waste arising from its operations.

Waste reduction measures may include:

- reducing use of water
- reducing use of chemicals or substitution of mineral salts – for example, potassium in place of sodium compounds
- recycling water and chemicals
- recovery and reuse of product from first reuse
- reuse/reprocessing of off-spec material
- recovering and reusing spilled raw materials and products.

Best practice management options for waste in decreasing order of preference are given in Figure 2.

Strategies for minimising waste in a dairy plant are suggested in Figure 3.

2.2 PROCESS CONTROL

Sources of waste

Dairy configuration and the products made affect the nature and concentration of dairy wastes. The amount of product lost depends on design and operational factors including:

- the range of process technologies in use
- the availability of adequate process monitoring, and plant and procedure alarms/interlocks
- the availability of automated operation – especially automated clean-in-place (CIP) systems and procedures
- the level of management and operator commitment, training and efficiency
- the level of routine equipment maintenance.

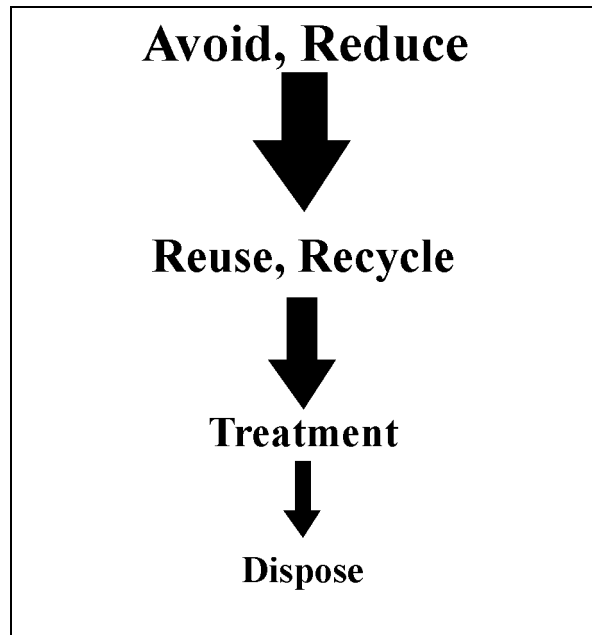


Figure 2 – Best practice management options for waste in order of preference

Plant	<ul style="list-style-type: none"> • area and layout for works • noise attenuation works
Processes	<ul style="list-style-type: none"> • prevent spillages • purge lines • automate CIP systems • maintain equipment • recover and recycle waste (membrane technology) • monitor processes (alarms, interlocks) • new technology
Personnel	<ul style="list-style-type: none"> • waste management program • staff training

Figure 3 – Waste minimisation strategies

Most site losses come from activities associated with liquid handling and, to a lesser extent, with the discharge of air and solid waste. Some examples of avoidable losses are:

- leaking valves, pumps, pipelines or other fittings – the volume lost may not be large but the pollution load may be great
- spills from overflows, malfunctions and poor handling procedures – spills usually happen over a short period but the amount and the high concentration of milk or product lost may be a significant increase in the pollution load
- losses from processing and cleaning during the normal operation of plant and equipment – this includes the deliberate discharge of unwanted materials such as whey, spent cleaners and diluted product not thought to be worth recovering.

Suggested measures for reducing waste

Liquid/packaged milk

Liquid milk production may lead to the generation of odour, wastewater, noise and solid waste.

Suggestions for avoiding wastes during liquid milk production are given in Figure 4.

Butter and dried products

Best practice involves processing the predominant by-products such as whey, buttermilk and skim milk, into high value products like skim milk powder (SMP), buttermilk powder (BMP), whey powder, whey protein concentrate and casein, rather than being used as low value animal feed/fertiliser or being dumped as waste.

Cream and butter are viscous and fatty and stick to equipment surfaces much more strongly than liquid milk, increasing the problem of removing residues. Hot water is an effective way to remove residual butterfat from cream processing and butter making equipment but the water temperature must not be too high (< 65°C) or there is the risk of “burning on” of some of the proteins. Whey should be dried where possible.

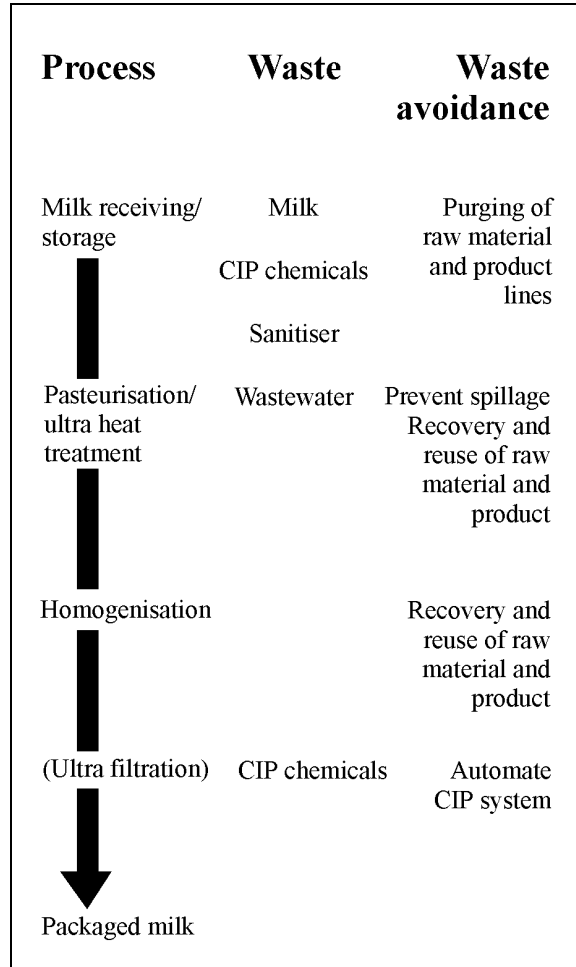


Figure 4 – Avoiding waste during liquid milk production

Production performance
<p>Objective</p> <p>To maximise production and minimise emissions.</p> <p>Suggested measures</p> <ul style="list-style-type: none"> • Recover maximum milk, fat, solids and chemicals. • Minimise losses or emissions to the environment. • Locate plant appropriately to minimise impact on sensitive residential or other land uses.

Prepare a waste management plan in accordance with the procedures outlined in *Waste Minimisation Assessment and Opportunities for Industry – A Practical Guide to Cleaner Production* (EPA Publication 351).

To initiate the process of cleaner production, a change in culture to waste minimisation is required. This involves moving from pollution treatment and control to anticipation and prevention of wastes.

Ways to prevent the build up of surface deposits include:

- minimisation of surface area
- prevention of build-up of milkstone deposits
- maintenance of butter churns
- correct preparation before filling
- not over-working the batch (this does not often happen with continuous butter making).

To avoid spills, buttermilk collection facilities should be large enough to hold all buttermilk discharged. Buttermilk should be dried or used as animal feed and solids recovered from butter wash water also may be sold as stock feed.

Suggestions for avoiding wastes during butter production are summarised in Figure 5.

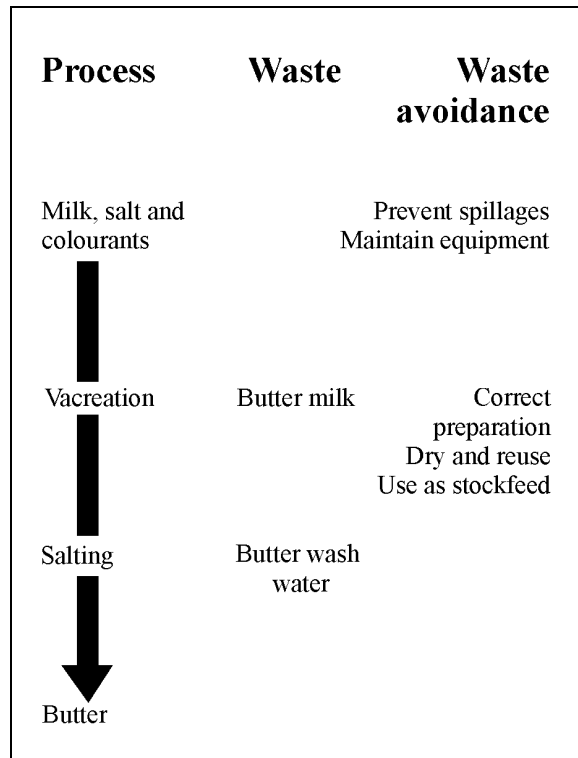


Figure 5 – Ways to avoid waste during butter production

Cheese and dried products

Making cheese generates a large volume of by-products such as whey.

Waste reduction can be achieved by:

- not overfilling cheese vats to stop curd loss
- completely removing whey and curds from vats before rinsing
- segregating all whey drained from cheese
- sweeping up pressings (particles)
- screening all liquid streams to collect fines.

These suggestions are summarised in Figure 6.

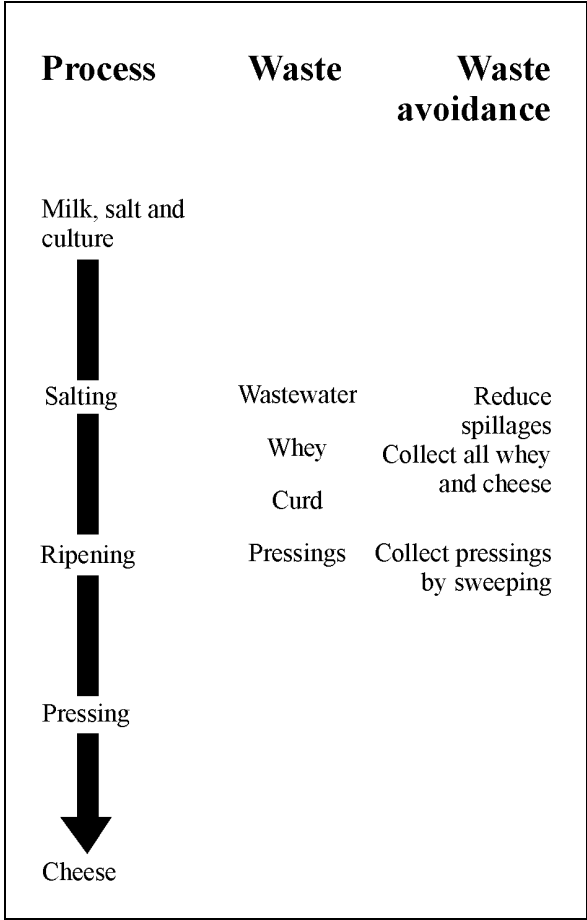


Figure 6 – Ways to avoid waste during cheese production

Evaporation and powder production

It is suggested that evaporators be operated to:

- maintain a liquid level low enough to stop product boil-over
- run to specified length – excessively long runs with higher than specified running rates lead to blocked tubes which not only produce high pollution, but are difficult and time-consuming to clean
- use effluent entrainment separators to avoid carry-over of milk droplets during condensation of evaporated water
- recirculate low concentration milk or other feed-stock until it reaches the required concentration
- process rinsings with 7% or more of solids before scheduled shutdowns, or evaporate them during the next run rather than discharging to the sewer
- minimise air emissions by using fabric filters or wet scrubbers.

These suggestions are summarised in Figure 7.

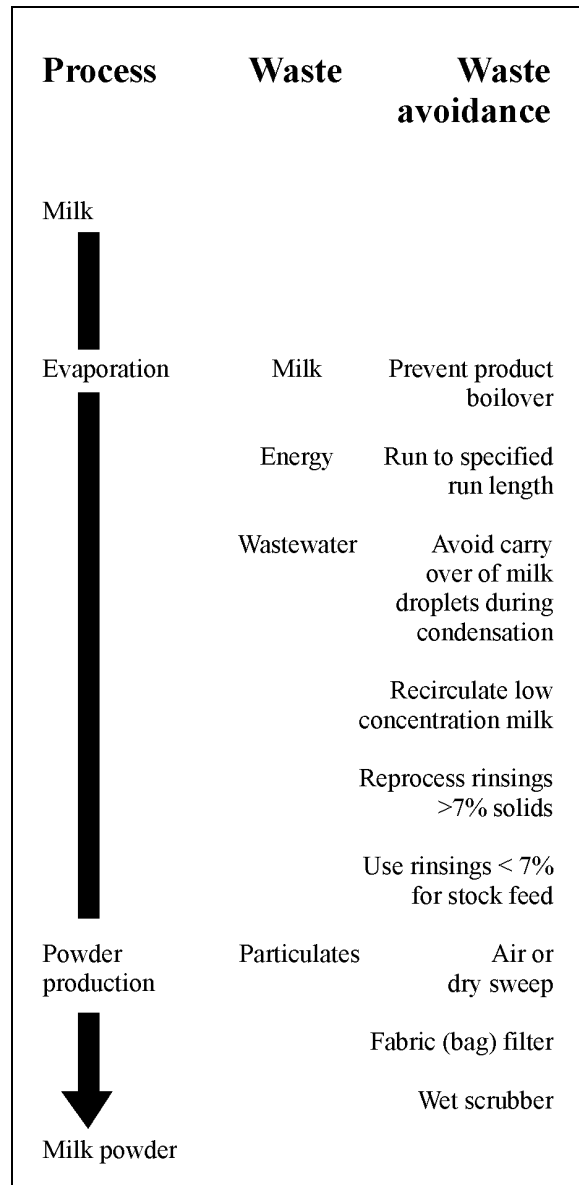


Figure 7 – Ways to avoid waste during powder production

3. ENVIRONMENTAL ELEMENTS

3.1 SITE SELECTION AND SITING

The selection of a site for the construction, replacement or expansion of a dairy plant should take into consideration nearby land uses, possible future developments, the volumes and nature of wastes produced and the proposed nature of waste recycling, reuse or disposal.

Depending on the proposed waste disposal system, adequate land should be available for treatment of wastewater.

Soil types should also be assessed on site to check whether they can provide reasonable drainage and have a good capacity to retain nitrogen, phosphorus and organic matter.

Generally, soils with textures ranging from medium loams to medium clays are suitable. Sandy soils are not suitable because of the risk of leaching of contaminants into underlying groundwater.

Similarly, wastewater should not be applied to heavy clay soils where water logging or surface run-off may occur.

Dairy plants and their associated wastewater treatment plants should not be located on a flood plain and should be a sufficient distance from surface water bodies and wetlands to reduce the risks of contamination caused by run-off or accidental spills. Similarly, wastewater treatment and disposal areas should not be sited above major ground water recharge areas such as gravel or sand beds or fractured rock aquifers.

Buffer distances

In order to provide a basic level of protection from odour, dust and noise, a dairy plant should not be located within a minimum buffer distance of designated residential areas or other sensitive land uses.

This is to protect the amenity of the area from unintended or accidental emissions which may arise from causes such as equipment failure, accidents and abnormal weather conditions. The buffer distance is measured from the nearest

dairy activity capable of emitting odour or particle emissions.

Buffer distances should not be regarded as an alternative to control of the emission source as discussed in sections 3.2, 3.3 and 3.4.

Air modelling studies may be necessary at the design stage for large operations when the buffer distances are close to the recommended minima.

Siting should also consider the need to protect sensitive natural water resources. Thus a dairy plant should not be sited within 100 metres of surface waters, nor be located on a flood plain or in declared special water supply catchment areas – unless adequate protection of surface and ground waters can be demonstrated by the proponent.

An ideal buffer distance between dairy processing operations and residential areas would be at least a kilometre. However, for facilities that operate their own anaerobic, aerobic or facultative wastewater treatment lagoons and irrigation-based disposal areas, this separation distance may vary from 200 to 2,200 metres – the distance depends on the flow rate and strength of the treated and disposed wastewater.

Site selection and siting
<p>Objective</p> <p>To ensure the dairy plant is sited to minimise environmental impact, consistent with the technology to be used.</p> <p>Suggested measures</p> <ul style="list-style-type: none"> • Soil assessment is undertaken • Site in accordance with buffer distance recommendations. • Site at least 100 metres from water courses. • Ensure there is sufficient land for future waste management facilities. • Consider current and future proximity of other developments.

Buffer distances usually are confined to new or *greenfield* sites, or to additional work on existing

sites. If there is to be substantial development on existing sites with inadequate buffer zones, the site developers usually must show that the introduced technology will allow for a variation of the recommended buffer distance.

If the recommended buffer distance is to be reduced for site-specific circumstances, the following performance criteria should be met.

- The plant's standard emission control technology is significantly better than the good level assumed by the buffer distance guidelines. Normally best practice technology is the necessary standard.
- An environmental audit of the site emissions has been undertaken.
- There has been no recent history of complaints from residual emissions for an existing plant.
- The topographic or meteorological characteristics which affect dispersion of emissions are evaluated.

The following requirements may be taken into account for minimising off-site emissions for any given site with defined boundaries:

- locate emission points to give maximum separation distances from adjoining residential or other sensitive areas with consideration of prevailing winds (Ausplume)
- use clean technology and/or best practice control technology
- ensure there are adequate operating practices, housekeeping and liaison with the local community.

3.2 AIR QUALITY

Types of emissions

The main emissions from dairy manufacturing processes are odours and particles.

Odours

Odours in and around milk processing plants come from the biological decomposition of milk-derived organic matter, generally found in wastewater. Often these odours are due to poor housekeeping, overloaded or improperly run

wastewater treatment and disposal facilities, and prolonged storage of strong wastes such as whey.

Particles

Particle emissions are caused either by combustion of solid or liquid fuel or, more often, spray drying of milk and whey. Excessive emissions are often sporadic and happen during plant upsets, shutdowns or start-ups.

The use of solid or liquid fuel such as briquettes and oil can result in fallout – carbonaceous ash particulate is usually emitted during boiler upsets or tube soot-blowing operations. Milk powder particles – while not toxic – accumulate on flat surfaces such as roofing, guttering and rainwater tanks, and may seriously compromise the quality of stormwater discharged from the site or taint the drinking water. A further source of annoyance to residents and factory workers is powder settling on nearby motor vehicles. The drier emissions depend on the product being dried – for example, skim milk tends to result in the highest emissions.

Air quality
<p>Objective</p> <p>To avoid or substantially reduce emissions so that there is no loss of amenity.</p> <p>The basis of these objectives is found in the <i>State Environment Protection Policy (The Air Environment)</i>.</p> <p>Suggested measures</p> <ul style="list-style-type: none"> • Maintain aerobic conditions for wastewater processing. • Use filters or scrubbers to eliminate or reduce particles. (Particles less than 20 mg/Nm³ represents best practice.) • Use automatic process control. • Carry out continuous routine monitoring of emission points using audible, visible alarms.

3.3 NOISE

Source of noise

The *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade, No. N-1)* requires that any noise due to activities at a premises in a sensitive area must not exceed the noise limits for the area, as determined by the methods set out in the policy. The limits are tighter outside the normal working day – such as the evening and especially at night.

Most milk processing plants are located in country areas where there are no residential statutory requirements for industry but EPA may set noise targets based on the *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade, No. N-1)* and guidelines and may use discretion in each particular case. In addition, there may be local government requirements on industrial noise.

The principal causes of continuous noise include:

- air discharges from drier stacks
- heater fans
- air supply fans
- ventilation
- boilers
- pumps
- cooling towers
- refrigeration units
- aerators on aerated lagoons.

Truck movements to and from the site or in streets are a source of noise, as are refrigeration compressors on trucks. This is a particular problem when fresh milk delivery means late night trucking.

Noisy operations at dairy plants include milk drying – which requires high airflows – and the movements of transport vehicles to and from the site.

Depending on the distance to sensitive receptors such as residential areas, suitable noise suppression or abatement measures – such as noise silencers on equipment, enclosure

of outdoor equipment, concrete housing for mechanical plant, mufflers on transport vehicles – may be required.

To reduce noise from aerated lagoons, adopt minimum capacity.

It may also be necessary to avoid carrying out certain operations or reduce noise levels:

- before 7am and after 6pm on weekdays
- before 7am and after 1pm on Saturday
- on Sunday
- on public holidays.

A detailed professional assessment of noise emissions should also be conducted.

Noise control
<p>Objective</p> <p>To ensure no noise nuisance results from the dairy plant.</p> <p>The basis of these objectives is found in <i>State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade, No. N-1)</i>.</p> <p>Suggested measures</p> <ul style="list-style-type: none"> • Concrete construction for buildings which house mechanical plant. • Sound silencers on air intake fans and air discharges. • Acoustic enclosure of outdoor mechanical plant such as pumps. • Careful siting of plant to maximise the shielding effect of other on-site structures. • Restricted operating hours. • Mufflers on transport vehicles. • Conduct noise assessment.

Table 1 – Typical noise limits in affected residential areas (dBA)

<i>Time of Day (hours)</i>	<i>Day (7am-6pm)</i>	<i>Evening (6pm-10pm)</i>	<i>Night (10pm-7am)</i>
Mainly residential	50-54	44-48	39-43
Residential, commercial or industrial	54-59	48-52	39-43
Commercial	56-59	52-57	47-52
Industrial	63-68	57-61	52-56

Source: *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade, No. N-1)*.

Note: Lower evening and night noise limits will apply in rural areas with low background noise levels.

3.4 WASTEWATER QUALITY

Protection of surface and groundwaters

Activities at dairy plants have the potential to contaminate both surface waters and groundwater. Water and land pollution can be avoided by appropriate siting, design, management and control of the dairy plant.

Sources of dairy wastewater

Approximately 65% of dairy factory losses enter wastewater discharge streams and these can have a major impact on the environment. The main sources of dairy processing plant wastewater are:

- raw material (predominantly milk) and product losses from leaking equipment and pipelines, and spills caused by equipment overflows and malfunctions and by poor handling procedures
- materials used for cleaning and sanitising
- by-products such as whey from the manufacture of cheese and casein.

Dairy plant processes which result in wastewater are listed in Table 2.

Table 2 – Sources of waterborne waste

Dairy processes		Sources of waste
<i>Preparation stages</i>		
Milk receiving/ storage	<ul style="list-style-type: none"> poor drainage of tankers spills and leaks from hoses and pipes spills from storage silos/tanks foaming cleaning operations 	
Pasteurisation /ultra heat treatment	<ul style="list-style-type: none"> liquid losses/leaks recovery of downgraded product cleaning operations foaming deposits on surfaces of pasteurisation and heating equipment 	
Homogen- isation	<ul style="list-style-type: none"> liquid losses/leaks cleaning operations 	
Separation/ clarification (centrifuge, reverse osmosis)	<ul style="list-style-type: none"> foaming cleaning operations pipe leaks 	
<i>Product processing stages</i>		
Market milk	<ul style="list-style-type: none"> foaming product washing cleaning operations overflowing poor drainage sludge removal from clarifiers/separators leaks damaged milk packages cleaning of filling machinery 	
Cheese making	<ul style="list-style-type: none"> overflowing vats incomplete separation of whey from curd using salt in cheese making spills and leaks cleaning operations 	
Butter making	<ul style="list-style-type: none"> vacreation and salt use produce washing cleaning operations 	
Powder manufacture	<ul style="list-style-type: none"> spills of powder handling start-up and shut-down losses plant malfunction stack losses cleaning of evaporators and driers bagging losses 	

Components of dairy wastewater

The major contaminants in dairy processing wastewater are milk solids that contain milk fat, protein, lactose and lactic acid. Other minor constituents include sodium, potassium, calcium and chloride.

Organic wastewater strength is measured by either BOD or COD.

Typical process wastewater has a biochemical oxygen demand (BOD₅) of about 2,000 mg/L and a dissolved solids concentration of 1,800 mg/L. BOD₅ is a measure of the amount of organic matter that is able to be biologically oxidised over a five day period.

Whey has a BOD₅ concentration of 30,000-40,000 mg/L. Where the whey is not used as a by-product but is discharged as effluent, it will increase the BOD level of wastewater and cause treatment and disposal problems. Whole milk has a BOD of 100,000 mg/L.

Although the throughput of milk in dairy plants is generally increasing, the technologies available for reducing and recycling wastes means that the volume of water used and wastewater generated is significantly less in modern plants.

Components of dairy plant wastewater are listed in Table 3.

Wastewater treatment and disposal

Because of the highly seasonal nature of milk production, during peak periods the volume of wastewater generated at dairy plants may be several times greater than during off peak periods.

The batch nature of many processes, and intermittent operations such as cleaning and sanitising, also means a wide daily variation in wastewater flows and quality.

Options for dairy factory wastewater include:

- treatment to a suitable standard for reuse or recycling
- discharge to local authority sewers under a trade waste agreement (with pre-treatment as necessary)
- appropriate treatment and land discharge wherever practicable and environmentally beneficial.

Table 3 – Range and average composition of dairy factory wastewater

Component	Range (mg/L)	Average (mg/L)
Suspended solids	24-5,700	–
BOD ₅	450-4,790	1,885 *
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
pH	4-12	7.1

* average yield loss (that is, wastage <2%)

Reuse and recycling

Many dairy plants have technologies in place for recovering wastewater and/or condensate (from production of milk powder) for reuse in the dairy plant. Reuse and recycling can considerably decrease the volume of mains water required to operate the plant and also reduce the cost of both mains water and wastewater disposal. Fats, milk solids and minerals can also be recovered from wastewater and recycled – either at the dairy plant or off-site. Cleaning chemicals can also be recovered and reused on site.

Treatment and discharge to land

Dissolved salts contained in dairy plant wastewater can adversely affect soil structure if wastewater is used to irrigate land. Wastewater can also leach into underlying groundwater and affect its quality.

Dairy plants should maximise the recovery, recycling and reuse of acids and alkali to minimise the dissolved salts and sodium levels in the wastewater. High salt levels affect the type of vegetation that grow.

Over-irrigation may cause the underlying water table to rise, resulting in further deterioration of surface soils and vegetation.

Discharge to sewer

Even if there is a local sewage authority that will accept wastewater, the volume and organic load of wastewater from just one dairy factory during peak season may well exceed the township's domestic waste. This may overload the sewage treatment plant, cause odours and give rise to poor effluent quality. Domestic wastewaters have a BOD₅ concentration of about 250 to 300 mg/L but in peak season a large dairy factory could be discharging two megalitres of wastewater at BOD₅ of 2,000 mg/L each day – the additional load on a sewerage plant is equivalent to an extra 16,000 persons.

Components of a wastewater system

Best practice wastewater treatment is given in Figure 8.

Segregation

Clean stormwater should be separated from contaminated stormwater and discharged directly into stormwater drains. Waste streams from the plant should also be segregated – for example, whey can be reused to produce whey powder or stockfeed.

Spent cleaning solutions should be separated from other wastewater streams as they can be treated to recover cleaning agents. Highly saline wastewater should also be discharged separately to an evaporation pond where the salts can be recovered and recycled.

Equalisation and pH control

A balance tank or pond will even out variations such as pH and temperature.

Alternative pH control can be achieved by using spent acid and alkali cleaners to neutralise each other.

Fat removal

Coarse milk solids should be removed by screening. Fats can constitute up to 50% of the organic load. Its recovery is therefore significant in any treatment process. Dissolved air flotation is a very effective method of separation.

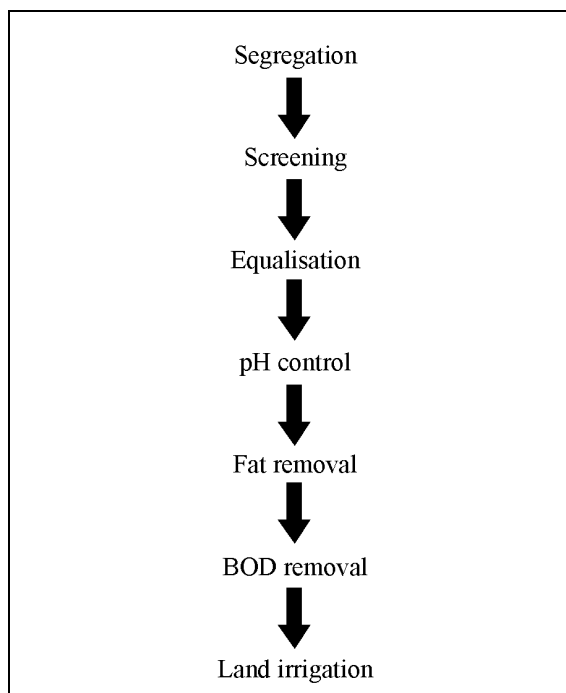
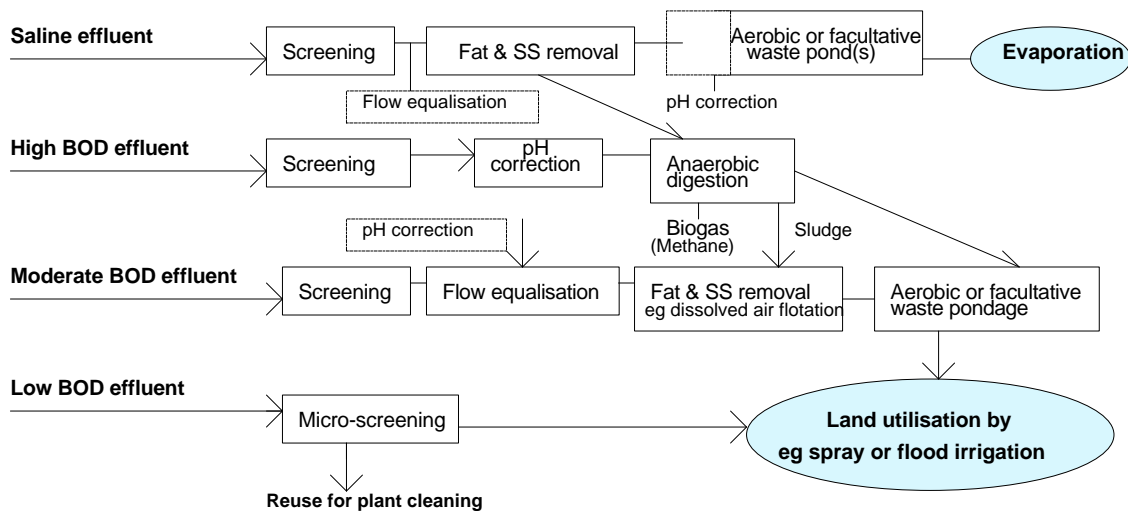


Figure 8 – Best practice for wastewater systems

Removal of organic load

Organic load can be reduced by physical methods – such as microfiltration, reverse osmosis and flotation techniques – or by biological treatments – such as activated sludge systems, trickling filters and anaerobic digesters. Lagoons, land irrigation and grass filtration systems can also reduce organic loads but reduction will occur at a slower rate than the previous methods. Best practice management of the waste stream may include removal of product before treatment.



Suggested options for treatment of segregated waste streams

Biological processes

Activated sludge

A highly effective method for treatment of dairy plant wastewater is the oxidation ditch. This is a development of the extended aeration process where aeration, settling and withdrawal of effluent all takes place in the same tank. The oxidation ditch process is characterised by a long retention time and low net sludge yield. This type of treatment lends itself to biological nitrogen removal.

Trickling filters

The best trickling filters have a free passage of air to prevent the generation of odours but are sensitive to high or low pH which may result in killing the biomass.

Lagoons

Highest quality wastewater and low odour generation can be achieved in aerated lagoons which use floating aerators to force oxygen input and resemble activated sludge systems.

Advanced treatment for reuse

Membrane filtration

This process has the potential for acid and alkali recovery and recycling. Best quality wastewater is obtained by pumping effluent through porous media containing millions of tiny pores. The media area is regularly cleaned by high pressure backwash using water and/or air.

Reverse osmosis

The removal of dissolved solids is best achieved by the passage of water through a semi-permeable membrane that restricts the movement of salts. This process for the desalination of wastewater is based on the osmotic pressures on either side of the membrane.

Land irrigation

In inland areas, treated wastewater can be either sprayed on the land or applied by flood irrigation using laser levelling and a ridge and furrow system. Grass filtration allows a greater application rate than irrigation and grass filtration systems generally are intended as a refining phase in the overall treatment system. In these cases, the majority of the BOD will have been removed by other means.

Emergency storage

High strength waste spills can be directed to small dams which have been built to prevent the treatment process from turning anaerobic.

Wastewater quality

Objectives

To ensure that no polluting discharge from dairy plant wastewater occurs to surface waters, groundwater or the land.

The basis of these objectives is found in the State environment protection policies for water and groundwater.

Suggested measures

- Prevent/reduce raw material and product losses.
- Reduce water use (less than 0.5 litres of water per litre of milk represents best practice).
- Treat wastewater to a suitable standard for reuse or recycling in accordance with *Guidelines for Wastewater Reuse* (EPA Publication 464) for the intended use.
- Design and construct wastewater treatment system and irrigate wastewater in accordance with *Guidelines for Wastewater Irrigation* (EPA Publication 168), such that loading rates and waste concentrations on irrigated pasture are less than:
 - ◆ 250 kg N/ha year for total nitrogen, depending on the vegetation/crop grown
 - ◆ crop uptake rate for phosphorus
 - ◆ 1,000 mg/L for total dissolved solids
 - ◆ 60 mg BOD/L for odour control.

3.5 SOLID WASTES

Solid waste often is the easiest to see, quantify and correct, and the volumes, treatment, transport and disposal costs are likely to be very evident on a plant's balance sheet.

Solid waste is generally:

- off-spec product – for example, milk powders and heavy consistency product
- defective product packaging – for example, paperboard cartons, plastic containers
- recovered wastewater treatment sludges
- solid and semi-solid intermediate or finished product spills.

Minimisation strategies range from common-sense housekeeping to detailed production planning to eliminate the generation of solid waste – for example:

- train staff so that spillages are minimised
- sweep up spills of solid materials such as cheese curd and powders to use as stock food – they should not be washed down the drain as this means more water is used and the volume and loading of wastewater is increased
- fit drain openings with screens and/or traps so that solid waste does not enter the wastewater treatment/disposal system – these solid interception devices must be maintained regularly, preferably daily
- use “off-spec” or contaminated product as stock food – if it is disposed to land, it must be in accordance with EPA requirements.

Solid wastes

Objective

To reduce the production of solid wastes and to reuse and recycle wherever possible.

Suggested measures

- Train staff to minimise spills.
- Use off-spec or spilled product as stock feed.
- Use dry sweeping to collect spills.
- Fit screens/traps to prevent solid wastes from entering waste water disposal system.

4. ENVIRONMENTAL MANAGEMENT

4.1 PLANT MANAGEMENT

Careful attention to quality assurance of the product is essential not only for marketing but also for responsible environmental management.

To achieve and sustain world best environmental management practices it is recommended that:

- a quality management system and an environmental management system that conform with the principles and practices of ISO9001 and ISO14001 be adopted and implemented
- an effective audit program be prepared and implemented to ensure that all resources have been effectively utilised
- an effective training program be prepared and implemented for all employees involved in control and verification activities
- a total quality management approach is adopted for the purpose of maintaining continuous improvement in process development through problem solving
- a protocol for quality assurance/quality control – particularly in relation to sampling and analysis – be adopted.

4.2 ENVIRONMENTAL MANAGEMENT

To achieve a consistently high level of environmental performance, a sound **environmental management system** is essential. The *Environment Management System (EMS) Standard ISO 14001* provides a useful guide.

BPPEM for dairy plants includes:

- a commitment from management to an environmental policy which is communicated to all employees
- adherence to BPPEM guidelines
- alert and informed supervision
- regular operator training

- exercising control over the product and the process through a QA/QC protocol
- detailed written procedures for each activity which are used by operational staff
- understanding and control of all wastes and emissions
- contingency plans, including:
 - procedures consistent with these guidelines for treating wastewater
 - procedures to minimise emissions (odour, particulates) to the air environment
 - procedures to minimise the generation of noise
- a high level of housekeeping on the site
- continuous improvement.

A well managed dairy plant would be expected to have an open attitude and good relations with the community, and a reputation of being responsible to community complaints and earning the community's respect as a provider of a positive environmental service.

An **Environment Improvement Plan (EIP)**, developed in consultation with the community, is a way of providing a structured approach to addressing environmental matters. Further information on developing EIPs is contained in *Environment Improvement Plans* (EPA Publication 394).

Operators who have an environment management system, EIP and environmental audit program are eligible for **accredited licensee** status with EPA. This provides operating benefits and reduced licence fees. Further information is available in *Accredited Licensee – Guidelines for Applicants* (EPA Publication 424).

Environmental management
<p>Objective</p> <p>To achieve a consistently high level of environmental performance through good management of a dairy plant.</p> <p>Suggested measures</p> <ul style="list-style-type: none"> • Have an environmental management system. • Write down the operating procedures. • Keep records. • Have contingency plans. • Have good housekeeping procedures. • Exercise quality assurance. • Develop good community relations. • Consider an EIP. • Minimise waste. • Regularly update systems.

4.3 RISK MANAGEMENT

Operators, through training and total quality management procedures, should be encouraged to:

- identify potential problems
- adopt a regular inspection and maintenance routine
- take appropriate corrective measures when problems do arise
- adopt operating and reporting procedures that seek to prevent problems happening again.

Accidents, equipment failure, climatic events and human errors often result in incidents where people and the environment are at risk.

Emergency preparedness

Dairy production plants should develop and maintain contingency plans. The plans should provide for the avoidance and control of spills, leakage or breakdowns so as to prevent pollution of the environment.

Contingency planning

The preparation of such plans should include:

- emergency holding procedures
- clean-up procedures
- action to minimise any adverse effects
- methods for disposal of spilled materials
- training of personnel in adequate identification of materials and correct operating procedures to avoid or minimise the likelihood of spills.

Other likely incidents which should be anticipated may include:

- disruption of power supplies
- human error
- disruption caused by acts of nature – such as storms, flooding, fire
- plant breakdowns – including drain blockages, pump failure
- waste overloading the treatment process
- temporary or permanent loss of trained personnel.

Risk management
<p>Objective</p> <p>To have procedures in place for the effective response to plant emergencies.</p> <p>Suggested measures</p> <ul style="list-style-type: none"> • Prepare and regularly update a contingency plan which is readily accessible. • Identify relevant employees and agencies to be contacted. • Communicate information on procedures. • Provide mechanism for reviewing incident response.

4.4 MONITORING AND REPORTING

Monitoring and reporting should be undertaken for performance purposes, and to ensure that plant and equipment are performing efficiently.

Monitoring and reporting is an integral part of an operation's environment management plan and should be developed in consultation with the relevant authorities on a site-specific basis. Records should be maintained of monitoring data and procedures should be reviewed periodically.

Plant managers should carefully observe the environmental performance of their plants and should institute remedial action should problems arise. Monitoring of waste and other environmental indicators may include:

- continuous monitoring of simple liquid, solid and gaseous waste indicators in processing streams or effluent
- key waste stream indicator monitoring on weekly to monthly basis or as specified in licence
- surface water and groundwater quality monitored monthly to quarterly and should include annual biological and bacteriological assessments where necessary, to check for any impacts on aquatic systems
- soils in waste utilisation areas should also be assessed for changes in chemical and physical characteristics, and to detect the onset of any soil degradation every five years
- key climatic parameters – such as rainfall and evaporation where irrigation is performed – should also be monitored on an annual basis.

Performance monitoring
<p>Objective</p> <p>To demonstrate the performance of a dairy plant against the environmental management objectives.</p> <p>Suggested measures</p> <ul style="list-style-type: none"> • Monitor effluent quality and quantity. • Monitor surface/groundwater quality. • Monitor soil quality. • Maintain records of monitoring data. • Review results and procedures annually. • Use an accredited NATA laboratory for analysis of samples. • Regularly inspect and maintain facilities and details recorded. • All monitoring, sampling and analysis undertaken in accordance with: <ul style="list-style-type: none"> •• <i>A Guide to Sampling and Analysis of Air Emissions</i> (EPA Publication 440) and •• <i>A Guide to Sampling and Analysis of Water and Wastewater</i> (EPA Publication 441).

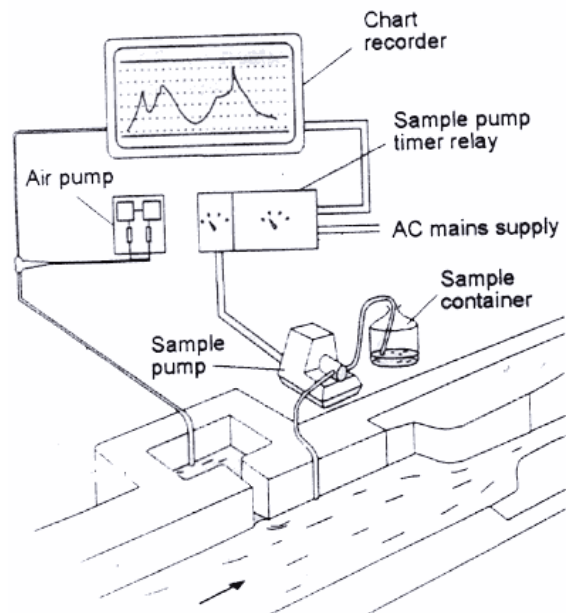


Figure 9 – Continuous on-line process monitoring

GLOSSARY

In these guidelines the following definitions apply.

Best practice

The practice of seeking out, emulating and measuring performance against the best standard identifiable.

Biochemical oxygen demand (BOD)

A measure of the oxygen demanding substances in wastewater – which indicates the level of pollution present. It records the number of milligrams of oxygen required by micro-organisms to oxidise the organics in a litre of the water over a period of time. It is expressed as milligrams per litre (mg/L).

CIP

Means clean-in-place.

Effluent

The liquid discharged from a treatment unit or system. It is qualified according to the type of treatment received (for example, sand filter effluent or treatment plant effluent).

Environment management plan

A plan covering the management of health and environmental risks.

EPA or the Authority

Means the Environment Protection Authority (Victoria).

Groundwater

Water located beneath the land surface.

Irrigation

The application of wastewater to land to replace soil moisture lost by evapotranspiration and to promote the growth of plants.

Nutrients

Substances that stimulate and enhance growth. Generally refers to nitrogen and phosphorus in waters.

Reclaimed water

Water that has been reclaimed from wastewater or sewage and treated to a standard which is satisfactory for its intended use.

Reuse

The application of appropriately treated wastewater for a specific purpose.

Sodium adsorption ratio (SAR)

A measure of the amount of sodium, relative to calcium and magnesium. SAR indicates the effect on soil structure and the reduced rate at which water moves through the soil.

State environment protection policy

State environment protection policies are developed and proclaimed under section 16 of the *Environment Protection Act 1970*.

Suspended solids (SS)

The non filtrable residual solids which are suspended in sewage or effluent. It is expressed in milligrams/litre (mg/L).

Surface waters

As defined in *State Environment Protection Policy (Waters of Victoria)*.

Treated effluent

Effluent that has been subjected to biological oxidation and clarification (not disinfection) to secondary standard.

REFERENCES

AS 3901/ ISO 9001, *Quality Systems for Design, Development, Production, Installation and Servicing*

Chandler Gilbert, VCAH, Seminar papers, *Whey as a Fertiliser and Waste Management in Dairy Factories*, February 1994

Harper W J , *Waste Management Control Handbook for Dairy Food Plants*, US EPA Publication No, 600/2-84-043

ISO 14000, *Standard for Environmental Management Systems*

National Water Quality Management Strategy, *Effluent Management Guidelines for Farm Dairies and Dairy Processing Plants, Working Draft*, 15 August 1994

Further information

A Guide to the Sampling and Analysis of Water and Wastewater, EPA Publication 441, 6th Edition 1995

Accredited Licensee – Guidelines for Applicants, EPA Publication 424, October 1994

Cleaner Production and the Water Industry, EPA Publication 362, February 1993

Environment Improvement Plans, EPA Publication 394, October 1993

Guidelines for Applicants – Research, Development and Demonstration (RD&D) Approval, EPA Publication 425, October 1994

Guidelines for Preparation of Waste Management Plans, EPA Publication 363, August 1993

Guidelines for Preparing Waste Assessments, A practical guide towards cleaner production, EPA Publication 277, October 1994

Guidelines for Wastewater Irrigation, EPA Publication 168, 2nd Edition 1991

Guidelines for Wastewater Reuse, EPA Publication 464, July 1996

Industrial Waste Minimisation – Procedures for Waste Assessments, EPA Publication 358, February 1993

Instructions of Completing Works Approval, Licence and Licence Amendment Applications, EPA Publication 375

Your suggestions

If you have any suggestions or comments about how we can improve these guidelines, please send them to EPA GPO Box 4395QQ, Melbourne 3001.

APPENDIX 1 – ENVIRONMENTAL LEGISLATION RELEVANT TO DAIRY PROCESSING PLANTS UNDER THE PROVISIONS OF THE *ENVIRONMENT PROTECTION ACT 1970*

All dairying facilities must conform with the relevant State environment protection policies and environmental regulations. The key objectives of these policies are incorporated in these guidelines.

Other information sources, as outlined below, are also available.

Legislation

Environment Protection Act 1970

The Act establishes the jurisdiction and powers of the Environment Protection Authority, and the segments of the environment to be protected.

Industrial waste management policy

Waste Minimisation – No. S52, Monday 29 October 1990

This policy aims to protect human health and the environment by minimising industrial waste, conserving resources, reducing costs associated with disposal, and improving cost efficiency of industry's waste avoidance.

The policy's attainment program requires all premises subject to works approval to have waste management plans identifying waste minimisation options, with a focus on waste avoidance, reduction and reuse.

Premises issued with Pollution Abatement Notices may also be required to develop and submit waste management plans.

State environment protection policies

State Environment Protection Policy (The Air Environment) – No. 63, Monday 13 July 1981 – as amended

Determines beneficial uses of the air environment to be protected, air quality indicators and objectives for specific gaseous

components, and attainment programs to achieve these objectives.

Its scope includes emission controls, the control of odour and the provision of buffer zones.

State Environment Protection Policy (Waters of Victoria) – No. S13, Friday 26 February 1988 – plus specific catchment policies where applicable

Determines beneficial uses of the water environment to be protected, water quality indicators and objectives for specific segments of the water environment, sets emission limits for components in any discharges, variations with locality, and attainment programs to achieve these objectives. Promotes waste minimisation.

State Environment Protection Policy (Groundwaters of Victoria) – Draft 1994

Protects groundwater from activities which are potentially detrimental to groundwater quality. The overall goal of this policy is to protect existing and potential beneficial uses of aquifers throughout Victoria by prevention of groundwater pollution.

Objectives for groundwater quality must not exceed those levels specified for the beneficial uses in *Australian Water Quality Guidelines for Fresh and Marine Waters* (Australian and New Zealand Environment and Conservation Council, 1992).

State Environment Protection Policy (Siting and Management of Landfills Receiving Municipal Wastes) – No. S40, Friday 5 July 1991

Protects existing and future beneficial uses of the air environment, surface waters and groundwaters and protects residents from the effects of landfills receiving municipal wastes. Promotes waste minimisation and resource recovery.

“Municipal waste” includes putrescible wastes and solid inert wastes from manufacturing, commercial, processing and service industries and waste generated within residential dwellings, but does not include liquid wastes, night-soil, or grease trap waste.

State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade No. N-1) – S31, Thursday 15 June 1989

Protects people from noise from commerce, industry and trade in the Melbourne metropolitan area. Applies to noise that may affect the beneficial use of noise-sensitive areas, and provides an attainment program to meet specified objectives.

(The policy is also used as a guideline elsewhere. Note that noise-sensitive areas include domestic, recreational and hospital activities – particularly sleep at night.)

Regulations

The following regulations have been made under section 71 of the *Environment Protection Act 1970*.

Environment Protection (Prescribed Waste) Regulations 1987

These regulations list all wastes which the Authority considers should be more stringently monitored and controlled. Most types of hazardous industrial or commercial processing wastes, effluents and residues are included as “prescribed wastes”. Inert wastes such as building rubble, uncontaminated packaging material and domestic wastes are not included. Infectious substances, lime sludges, oil water mixtures and grease interceptor trap effluents and residues are included in the list of prescribed wastes, so that their generation, transport and disposal offsite can be controlled and monitored.

Environment Protection (Transport) Regulations 1983

These regulations require the use of waste transport certificates for the transport of prescribed industrial waste. Any vehicle used for transport of prescribed industrial waste

(with minor exceptions) must hold an EPA Transport Permit.

The Transport Certificate system allows EPA to track wastes from cradle to grave and gives useful information regarding the amounts of prescribed waste generated, transported and disposed of in the State.

Environment Protection (Scheduled Premises and Exemptions) Regulations 1996

The Regulations identify the following as scheduled premises:

- dairy plants producing more than 200 tonnes of product a year
- premises which discharge more than 5,000 litres a day of sewage
- premises which emit more than 100 kilograms of particulate matter a day, or
- premises which accept prescribed wastes, generated offsite, for the purposes of storage, reprocessing, treatment or disposal.

Certain premises which reuse wastewater or discharge to sewer are exempt under the Regulations.

Before any works or major process modifications are carried out at scheduled premises, an EPA works approval may be required. Operating conditions for the premises are covered by an EPA licence which must be obtained before the start of operations.

Licences and works approvals for these premises consider any environmental hazards that may be associated with the facility and place conditions on operations such as the storage of wastes, screening of incoming wastes, maintenance of accurate records and limitation on the types of wastes accepted by the facility.

These guidelines have been documented to provide a summary of issues and assistance in understanding EPA requirements. They are for guidance only and are not intended to be either prescriptive or exhaustive. Each situation will be assessed according to its merits by EPA.

APPENDIX 2 – QUICK REFERENCE AND CHECKLIST FOR DAIRY PLANTS

Issue	Objectives are achieved by	Ref.	✓
Cleaner production		5	
• waste minimisation		5	
• process control:		5	
- sources of waste		5	
• measures for reducing waste:		6	
- liquid/packaged milk		6	
- butter and dried products		6	
- cheese and dried products		7	
- evaporation and powder production		9	
Environmental elements		10	
• site selection and siting		10	
• air quality		11	
• noise		12	
• water quality		13	
• solid waste		18	
Environmental management		19	
• plant management		19	
• environmental management		19	
• risk management		20	
• monitoring and reporting		21	
Regulatory requirements		24	
Environmental policies, SEPPs and IWMPs		24	
Scheduled premises		25	
Waste transport		25	
Prescribed waste		25	

This checklist summarises the specific environmental issues that need to be addressed in a dairy plant. Provision is made in the list for managers to check off each issue as it relates to a plant.

The issues are listed in the same order as they appear in the Guidelines.

APPENDIX 3 – EPA REGIONAL OFFICES

Gippsland

7 Church Street, Traralgon 3844

Tel: (03) 5176 1744 Fax: (03) 5174 7851

North-East

24 Ely Street, Wangaratta 3677

Tel: (03) 5721 7277 Fax: (03) 5721 2121

North-West

261 Hargreaves Street, Bendigo 3550

Tel: (03) 5442 4393 Fax: (03) 5443 6555

South Metro

45 Princes Highway, Dandenong 3175

Tel: (03) 9794 0677 Fax: (03) 9794 5188

South-West

Cnr Lt Malop & Fenwick Streets, Geelong
3220

Tel: (03) 5226 4825 Fax: (03) 5226 4632



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