Tasmanian Biosolids Reuse Guidelines

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1. Preface

This publication is a revision of the document with the same title produced by the Department of Primary Industries, Water and Environment in 1999. Where possible, this revision seeks to standardise requirements for the classification and reuse of biosolids with other contemporary biosolids reuse guidelines in place in other jurisdictions.

This Guideline does not have legal force however it is written with a view to being made enforceable under legal instruments such as land use permits, environment protection notices, approved management measures and other environmental approvals. As such, mandatory language (e.g. 'must' or 'restriction') is used in relation to critical elements of this Guideline.

2. Introduction

Sewage sludge is the solid, semi-solid or liquid residue generated during the treatment of sewage in the wastewater treatment process.

Biosolids is the term used to describe sewage sludge that has been sufficiently stabilised and can be beneficially used for its nutrient, soil conditioning, and/or energy qualities. Biosolids products are any material containing biosolids such as compost and biosolids pellets. Biosolids and biosolids products are subject to the requirements of these Guidelines, and where the term 'biosolids' is used it includes 'biosolids products'. Most biosolids produced in Tasmania are applied to agricultural land. Untreated sewage sludges, septic wastes, industrial or food processing sludges, animal manures, or abattoir wastes are not biosolids.

Despite having beneficial properties, biosolids may pose human health and environmental risks if not carefully managed. As such, re-use of biosolids is a regulated activity in Tasmania. These Guidelines inform and underpin regulatory settings for biosolids re-use by establishing a classification system that limits the use of biosolids according to level of risk. The purpose of these Guidelines is to allow the environmentally sustainable and safe use of biosolids in Tasmania.

The Guidelines are relevant to:

- *Producers* – owners or operators of wastewater treatment plants (WWTPs) and associated on-site and off-site biosolids storage facilities, or their contractors.
- *Reprocessors* – owners or operators of biosolids processing facilities (e.g. composters, chemical stabilisers), or their contractors.
- *Transporters* – producers, reprocessors or contractors who transport sewage sludge or biosolids.
- *End users* - farmers, mining companies, foresters, municipal authorities, landscaping contractors who use biosolids products.
- *Sewage sludge and biosolids re-use regulators* - primarily local councils and the EPA, but also including Tasmania's Chief Veterinary Officer and the Director of Public Health.

2.1 Scope

The Guidelines apply to the following products:

1. Liquid biosolids from digesters or sewage lagoons
2. Digested biosolids
3. Chemically stabilised biosolids
4. Dried biosolids (including sun/air dried, thermally dried)
5. Composted biosolids products
6. Products that contain biosolids

The Guidelines do not apply to the following products:

1. Trade waste discharges
2. Grease trap wastes
3. Screenings, grit and scum
4. Sewer silt and stormwater waste
5. Industrial waste
6. Drinking water treatment sludges
7. Domestic septic tank wastes
8. Ash from combustion of sewage sludge

The principles and management practices in these Guidelines may also be applicable to sludges from other treatment processes or industries. Advice regarding the management of materials to which the Guidelines do not apply should be sought from the relevant authorities.

2.2 Objectives

The specific objectives of the Guidelines are:

- To set biosolids quality standards which adequately protect human and animal health, the environment and soil quality whilst providing practical options for the beneficial use of biosolids.
- To ensure the use of best management practices to support sustainable, practical and safe beneficial use options for biosolids.
- To set out the legal framework within which sewage sludge and biosolids are regulated and detail the statutory obligations of relevant parties to ensure that relevant regulatory requirements are met.

2.3 How to use the Guidelines

There are three steps to using the Guidelines:

1. Classify biosolids by establishing the “Contaminant Grade” and “Stabilisation Grade”. Classification and sampling procedures are detailed in Sections 6, 7, 8 and 9 and Appendices B and C.
2. Determine the permitted beneficial re-use options based on the classification (refer to Section 9).
3. Apply best management practices and constraints for identified re-use options (Sections 10, 11, 12 and 13).

3. Definitions

Term	Definition
Aerobic Digestion	The decomposition of the organic matter by micro-organisms into carbon dioxide and water, in the presence of oxygen.
Anaerobic Digestion	The decomposition of the organic matter by micro-organisms into methane, carbon dioxide and water, in the absence of oxygen.
Application Site	The area over which biosolids are applied or used.
AMM	Approved Management Method for Biosolids Reuse – document approved by the Director, EPA in accordance with regulation 19, *Environmental Management and Pollution Control (Waste Management) Regulations 2020* which stipulates legislative requirements for the beneficial use of biosolids.
ASCC	Actual Soil Contamination Concentration – used in calculating limiting application rates for biosolids applications (see Appendix D).
AS 4454:2012	*Australian Standard: Composts, Soil Conditioners and Mulches* (Standards Australia Ltd, 2012) - details labelling requirements for organic products and mixtures which meet the minimum requirements set out in the standard.
BACC	Biosolids Adjusted Contaminant Concentration - a statistically modified measure of contaminant concentration of biosolids. The BACC must not exceed the specified Contaminant Acceptance Concentration Threshold for biosolids to be accepted for a particular use.
Batch	A discrete and traceable quantity of biosolids which may be classified according to these Guidelines.
Beneficial Use	The use of biosolids for any purpose which provides benefit without harming or threatening public health and safety or the environment.
Biosolids	Sewage sludge which has been sufficiently stabilised, classified in accordance with these Guidelines, and which can be beneficially used for its nutrient, soil conditioning, and/or energy qualities
Biosolids Products	Material containing any component of biosolids including undiluted biosolids in the form of liquid or cake, or derived materials such as compost, lime amended biosolids or pellets.
Blending	The mixing of several products to form one product.
Buffer Zone	An area of vegetated land between an area where biosolids are to be applied and a drainage line, creek, river or other sensitive area.
Bund	A wall structure, usually formed with soil, designed to retain or exclude run-off.

Term	Definition
CACT	Contaminant Acceptance Concentration Threshold – the contaminant concentrations below which biosolids may be accepted for beneficial reuse.
CFU	Colony Forming Unit - A measure of viable bacterial or fungal numbers.
CLAR	Contaminant Limiting Application Rate – the maximum rate at which biosolids can be applied without exceeding the Maximum Allowable Soil Contaminant Concentration (MASCC).
Classification	The process of assigning biosolids into classes based on quality as determined through grading.
Composting	A process in which solid organic materials are broken down by micro-organisms in the presence of oxygen. For biosolids composting involves mixing with sawdust, wood chips or other carbon-rich organic material. High temperatures generated during this process kill harmful micro-organisms. A rich, soil-like product is the end result.
Contaminant	Metals, organic compounds (including pharmaceuticals and pesticides) and physical contaminants (such as plastics) occurring in biosolids and soils.
Contaminant Grade	Grading category used to describe the quality of a biosolids based on the concentration of its constituent contaminants.
Controlled Waste	As defined in Section 3(1) EMPCA.
Dewatered Biosolids	Biosolids which have gone through a process to reduce water content and produce a solid, spade-able product, typically in the range 15-35% solids content.
DMB	Dry Matter Basis, the mass of a substance excluding any moisture.
E. coli	*Escherichia coli* is a bacterium that is commonly found in the lower intestine of warm-blooded animals. Its ability to survive for brief periods outside the body makes it an ideal indicator organism to test environmental samples for faecal contamination.
EMPCA	The *Environmental Management and Pollution Control Act 1994* is the primary environment protection and pollution control legislation in Tasmania.
Environmental Nuisance	As defined in Section 3(1) EMPCA.
Environmental Harm	As defined in Section 5 EMPCA.
EPA	Environment Protection Authority, Tasmania
EPA Tasmania	Division of the Department of Primary Industries, Parks, Water and Environment, Tasmania which administers EMPCA.
EPN	Environment Protection Notice can be issued by the Director, EPA or Local Government under Division 2 of Part 4 EMPCA. EPNs are regulatory instruments used to ensure compliance with appropriate standards to mitigate against the risk of environmental harm or nuisance.

Term	Definition
Grading	Process of assessing biosolids on the basis of constituent contaminants (contaminant grade), and degree of stabilisation (stabilisation grade) so that they may be classified.
Groundwater	Water saturating the voids in rocks and soil.
IB 105	Information Bulletin 105: Classification and Management of Contaminated Soil for Disposal.
Incorporation	Mixing biosolids with the soil, for example by injection, ploughing, roto-tilling or tandem disc harrowing.
Land Application	Spreading onto or incorporation of biosolids into the land.
Lime Amended Biosolids	Biosolids that have had sufficient lime added to destroy or inhibit pathogens and micro-organisms involved in the decomposition of the biosolids.
Liquid Biosolids	Biosolids in a liquid form, generally containing less than 10% solids and most commonly with 2-5% solids.
LUPAA	*Land Use Planning and Approvals Act 1993* is the legislation under which development proposals may be required, are assessed and approved. If a development application is approved, Local Government issues a permit detailing restrictions and requirements including environmental conditions.
MABAR	Maximum Allowable Biosolids Application Rate – the maximum application rate at which biosolids can be applied. This is the most restrictive value obtained from the determination of the CLAR and NLAR.
MASCC	Maximum Allowable Soil Contamination Concentration - the recommended maximum concentration of a contaminant in a soil.
MPCAR	Maximum Permissible Cadmium Application Rate – the calculated maximum application rate of cadmium.
NLAR	Nitrogen Limiting Application Rate – the maximum rate at which biosolids can be applied without exceeding the agronomic nitrogen requirements.
Organic Carbon	Organic carbon (or organic matter) derived from a once-living organism; is capable of decay or is the product of decay; or is composed of organic compounds.
National Guidelines	*Guidelines for Sewerage Systems, Biosolids Management* (National Water Quality Management Strategy, 2004).
NBRP	National Biosolids Research Program
Pathogens	Disease-causing organisms.
PFU	Plaque Forming Unit – a measure of viable virus numbers.
Regulation 21 Approval	Refers to an approval which may be obtained under the *Environmental Management and Pollution Control (Waste Management) Regulations 2020* for sewage sludge and biosolids reuse proposals which do not meet the requirements set out in these Guidelines or under the AMM.

Term	Definition
Reprocessing	The modification of the physical, chemical or microbiological form of sewage sludge or biosolids to produce a biosolids product for beneficial use.
Sewage	Water borne waste of human origin comprising faecal matter, greywater, urine or liquid household waste (*Building Regulations 2016*)
Sewage Sludge	A solid, semi-solid or liquid residue generated during the treatment of sewage in a treatment works.
SM	Incorporated Soil Mass per hectare - used in calculating limiting application rates for biosolids applications (Appendix D)
Soil Conditioner	A substance used to improve the physical (e.g. soil structure) or chemical (e.g. pH) properties of soil.
Surface Water	Any river, stream, lake, lagoon, swamp, wetland, unconfined surface water, dam or tidal water. A river or stream may be perennial or intermittent, flowing in a natural channel with an established bed or in an artificially modified channel which has changed the course of the stream.
Stabilisation	The processing of biosolids to reduce or eliminate the potential for putrefaction and thus reduce pathogens, vector attraction and offensive odours.
Stabilisation Grade	Grading category used to describe the quality of biosolids based on its microbiological characteristics, vector attraction and potential to generate offensive odours.
Vector	Any insect or animal, such as flies, mosquitoes and rodents, which are attracted to the putrescible organic material in biosolids and which may spread pathogens.
Vector Attraction	The characteristics of biosolids that attracts rodents, flies, mosquitoes or other organisms capable of transporting disease.
Vector Attraction Reduction	Process of reducing the characteristics of biosolids that attract rodents, flies, mosquitoes or other organisms capable of transporting disease.
Volatile Solids	The solids in sewage sludge which can be volatilised and burned off when ignited at 550 ± 50°C.
Waste Regulations	*The Environmental Management and Pollution Control (Waste Management) Regulations 2020* are used to define and regulate the management of controlled wastes and general wastes in Tasmania.
Water Table	The level below which the ground is completely saturated with water.
WWTP	Wastewater Treatment Plant - A processing facility that treats sewage and, in the process, produces sewage sludge and treated effluent and minor residuals (screenings and grit).

4. Biosolids

4.1 Beneficial Components of Biosolids

Biosolids contain useful amounts of nitrogen, phosphorus and organic carbon and limited quantities of potassium and trace elements making them ideal for soil conditioning and use as a fertiliser. Biosolids may also contain lime if this is added during the stabilisation process. The availability of these nutrients and the amount of organic carbon present depend on the treatment process used at the wastewater treatment plant, and subsequent stabilisation process.

As well as being used for agriculture, biosolids can be used for silviculture, site rehabilitation, as an energy source, and have been used as a component in materials such as concrete and bricks.

4.2 Potential Risks of Biosolids

As municipal wastewater comprises a range of domestic, commercial and industrial sources, various pathogenic organisms, and organic and inorganic contaminants may be found in biosolids. These constituents, if not appropriately monitored and managed, may pose a potential risk to humans, animals, plants, soil health and/or the environment. Appropriate use of biosolids is also important for economic reasons such as helping to protect the reputation of Tasmania's agricultural produce.

Australian jurisdictions adopt a conservative approach to ensure that the risks of environmental or public health problems associated with biosolids reuse are minimal. This is the approach taken in these Guidelines. While this approach may make it more difficult for some biosolids to be beneficially used, it should engender public confidence in public health and environmental protection systems.

4.2.1 Pathogens

Due to its nature, sewage sludge, if inadequately treated or inappropriately managed, carries a significant health risk through potential for spreading disease by pathogenic organisms. Pathogenic organisms found in sewage may include bacteria, protozoa, viruses and helminths. The numbers of these micro-organisms are reduced during the wastewater treatment process, and appropriate stabilisation of sewage sludge, to acceptable levels safe for the intended end use. Coupled with appropriate land, public access and stock management measures, this can be expected to minimise potential human and animal health risks. Section 8 details minimum treatment requirements and microbiological quality criteria for beneficial use of biosolids.

4.2.2 Chemical Contaminants

A range of chemical contaminants may be present in biosolids. A large research effort over recent decades has focused on identifying those contaminants, including metals, pesticides, pharmaceutical and persistent organic pollutants which may be present in detectable concentrations in biosolids and pose a significant risk.

Most of the metal contaminants that occur in biosolids are also trace elements which are important for healthy plant growth. These Guidelines address potential risks posed by certain metal contaminants by establishing threshold concentrations that determine reuse options for any given batch of biosolids.

Based on information available to EPA Tasmania, pesticides previously thought to be a concern in biosolids have rarely, if ever, been detected above contaminant Grade A concentrations stipulated in the 1999 version of these Guidelines. Most of these pesticides have been banned under the Stockholm Convention (2001) for many years. On this basis, the requirement for testing these contaminants has been removed from this revision of the Guidelines.

Research in recent years into concentrations of a large number of emerging synthetic compounds found in biosolids has found that while they are present, typical application rates of biosolids mean these compounds are unlikely to be present in concentrations that pose a risk. Furthermore, the majority of these compounds are broken down through various decay processes once land applied. These emerging synthetic compounds can be found in many products including pharmaceuticals, personal care products and domestic products.

However, perfluorinated alkylated substances (PFAS), specifically perfluorooctanesulfonic acid (PFOS), perfluorohexane sulfonate (PFHxS) and perfluorooctanoic acid (PFOA) which, due to their persistence and physical properties, research indicates are present in some biosolids at levels which warrant specific monitoring. These Guidelines include a requirement for monitoring these contaminants in biosolids produced at WWTPs with catchments which include inputs with the potential to contain elevated levels of these contaminants.

4.3 Statutory Framework

Due to the potential risks posed by sewage sludge and biosolids, the handling, movement, use and disposal of these materials is controlled by environmental legislation.

The *Environmental Management and Pollution Control Act 1994 (EMPCA)* is the primary environment protection and pollution control legislation in Tasmania with a focus on prevention, reduction and remediation of environmental harm, particularly from pollution and waste. Under EMPCA environmentally polluting activities are divided into categories and the responsibility for the regulation of activities is split between EPA Tasmania and Local Government.

Biosolids reuse activities are either:

- A "permitted use". Under some Local Government Planning Schemes biosolids land application reuse activities may be considered a "permitted use" (agricultural right) and therefore may not require a permit under LUPAA. Local Government has an obligation, even in those cases which do not require a permit, to ensure pollution does not arise as a consequence of these activities;
- A "Level 1" Activity under EMPCA. That is, an activity which may cause environmental harm and in respect of which a permit under the *Land Use Planning and Approvals Act 1993 (LUPAA)* is required but does not include a Level 2 or a Level 3 activity. Local Government are the regulatory authority of Level 1 activities; or
- A "Level 2" Activity under EMPCA. That is, an activity which may cause environmental harm and in respect of which a permit under the *Land Use Planning and Approvals Act 1993 (LUPAA)* is required and the activity meets or exceeds the thresholds defined in Schedule 2, EMPCA. EMPCA Schedule 2, clause 3(d)(ii) stipulates the application to land of class 2 biosolids, where the application rate is 50 wet tonnes or more per hectare every 3 years or greater than 50% of the Nitrogen Limiting Application Rate per 3 year period, is a Level 2 Activity. The EPA is the regulatory authority of Level 2 activities.

The *Environmental Management and Pollution Control (Waste Management) Regulations 2020 (*the Waste Regulations*)* are made under EMPCA and are used to regulate the management of controlled waste and some aspects of the disposal of general waste. The Waste Regulations define "sewage sludge, sewage residue, night soil or sludge from an on-site wastewater management system" as a Controlled Waste. Biosolids and biosolids products are a general waste.

Made under section 19 of the Waste Regulations, the *Approved Management Method for Biosolids Reuse* (the AMM) sets out the maximum application rates, application frequency and management requirements for the different classes of biosolids for the reuse activity to be exempt from the full assessment process required for a Level 2 Activity. Under the AMM, reuse of Class 1 biosolids is not a Level 2 Activity on the proviso the Nitrogen Limiting Application Rate (NLAR) is complied with (see Appendix D). The AMM clarifies that the limiting application rate for a Level 1 Activity utilising Class 2 Biosolids is less than 50 wet tonnes per hectare every 3 years or less than 50% of the Nitrogen Limiting Application Rate **(whichever is the lesser).** Thus, ensuring that, in order to be compliant with the AMM, both limitations are considered.

Refer to Appendix E for an overview of these processes.

It may be possible in certain circumstances to obtain approval for a use of biosolids which does not fit within the scope and limitations set out in these Guidelines. Proposals that fall into this category may be submitted to the EPA for consideration under Regulation 21 of the Waste Regulations.

It is important to remember that all sewage sludge removed from WWTPs is deemed to be a Controlled Waste unless analysis demonstrates otherwise. As such there are also legislative restrictions on its transportation under Part 3 of the Waste Regulations.

The operators of a WWTP may also have specific requirements regarding the management of sewage sludge and biosolids through conditions imposed in a permit or Environment Protection Notice. EPA Tasmania reports on the volumes of biosolids produced by TasWater's Level 2 WWTPs, and volumes that have been beneficially used in the annual State of Industry Report produced by the Office of the Tasmanian Economic Regulator.

A summary of other legislation which is relevant to the handling of sewage sludge and beneficial use of biosolids can be found in Appendix A.

5. Roles & Responsibilities

This section outlines the responsibilities of all major stakeholders involved in the treatment and reuse of biosolids.

5.1 Producer

The Producer is responsible for:

- Ensuring all sewage sludge and biosolids produced by their premises receives the required treatment and testing and ensuring that the end use is compliant with the requirements of these guidelines, including the maintenance of all required records.
- If transporting sewage sludge, ensuring they have the appropriate registration under the Waste Regulations.
- The management of the WWTP, including any sludge treatment facilities, to ensure sludge treatment processes are optimised and the material meets minimum treatment requirements set out in these Guidelines.
- If intended for beneficial use, undertaking the analysis of biosolids in accordance with the sampling requirements detailed in Appendix B to establish the contaminant and stabilisation grading and nutrient content.
- If biosolids are being taken from a Producer-owned WWTP or biosolids handling facility directly to the reuse site, determining the Maximum Allowable Biosolids Application Rate (MABAR) (see Section 12) as appropriate and ensuring the AMM will be complied with and any relevant approvals (LUPAA permit, or Regulation 21 Approval) have been acquired.
- If sewage sludge, which is a Controlled Waste, is being taken from a Producer-owned WWTP or sewage sludge handling facility to a Reprocessor, ensuring that the Reprocessor is approved to accept the material, and providing all relevant analysis and classification of the material to the Reprocessor.
- If using a contractor to transport sewage sludge, ensuring the Transporter is registered under the requirements of the Waste Regulations.
- Ensuring the End User is aware of the relevant restrictions which apply to storage, handling and use of the biosolids and restrictions on land use post application, as per these Guidelines.
- Maintaining all required records as stipulated in these guidelines.
- Maintaining a record of all properties running cattle where biosolids are applied to grazing or fodder crops.
- Meeting all relevant permit and EPN requirements.
- Ensuring all workers handling biosolids understand the health risks associated with the material and have sufficient training to know how to manage these risks.

5.2 Reprocessor

The Reprocessor is responsible for:

- Ensuring they have the appropriate approvals to receive sewage sludge.
- Management of the reprocessing facility to ensure the material meets minimum treatment requirements set out in these Guidelines.
- Undertaking the analysis of final product containing sewage sludge or biosolids in accordance with the sampling requirements detailed in Appendix B to establish the contaminant and stabilisation grading and nutrient content of the material.
- If biosolids are being taken from a reprocessing facility directly to the reuse site, determining the Maximum Allowable Biosolids Application Rate (MABAR) (see Section 12) as appropriate and ensuring the AMM will be complied with and any relevant approvals (LUPAA permit, or Regulation 21 Approval) have been acquired.
- If using a contractor to transport sewage sludge, ensuring the transporter is registered under the requirements of the Waste Regulations.
- Ensuring the end user is aware of the relevant restrictions which apply to storage, handling and use of the biosolids and restrictions on land use post application.
- Maintaining all required records.
- Maintaining a record of all properties running cattle where biosolids are applied to grazing or fodder crops and providing this information to the Producer.
- Meeting all relevant permit and EPN requirements.
- Ensuring all workers handling biosolids understand the health risks associated with the material and have sufficient training to know how to manage these risks.

5.3 Transporter

The Transporter is responsible for:

- Ensuring they have the appropriate registration, under the requirements of the Waste Regulations to move sewage sludge.
- Ensuring their vehicles are adequately maintained and meet the requirements of any conditions imposed by their registration, including provision of spill kits.
- Reporting Controlled Waste movements as required under the Waste Regulations, including origin, destination, quantity and classification (as provided by the Producer or Reprocessor).
- Ensuring all workers handling sewage sludge or biosolids understand the health risks associated with the material and have sufficient training to know how to manage these risks.

5.4 End User

The End User is responsible for:

- Ensuring biosolids are stored and applied in accordance with the relevant requirements detailed in sections 10, 11 and 12 of these Guidelines, the AMM and any relevant permit or EPN requirements.
- Maintaining all required records.
- Ensuring all workers handling biosolids understand the health risks associated with the material and have sufficient training to know-how to manage these risks.

5.5 Local Government

Local Government is responsible for:

- Administering EMPCA in regard to activities that are not level 2 or level 3 activities, including the assessment and permitting as necessary, and regulation of development proposals under LUPAA.
- Responding to any incidents resulting from biosolids activities with the potential to cause environmental nuisance and/or affect public health.
- Regulating 'Level 1' wastewater treatment plants.
- Providing advice on applying these Guidelines.

5.6 Environment Protection Authority

The EPA is responsible for:

- Ensuring an appropriate response is made to any reported incidents from any biosolids activity with the potential to cause serious or material environmental harm.
- Regulating 'Level 2' wastewater treatment plants and biosolids land application activities.
- Providing advice on applying these Guidelines.

5.7 Director of Public Health, Department of Health

The Director of Public Health is responsible for:

- Consultative role in production of these Guidelines.
- Providing advice in relation to public health issues that may arise in applying these Guidelines.

5.8 Chief Veterinary Officer, Department of Primary Industries, Parks, Water and Environment

The Chief Veterinary Officer is responsible for:

- Consultative role in production of these Guidelines.
- Providing advice in relation to animal health issues that may arise in applying these Guidelines.

6. Biosolids Classification Process

Biosolids intended for beneficial use must be classified on the basis of analysis of representative samples of the product (see Appendix B).

The classification system comprises two classes which reflect different permissible end uses, commensurate with risk. Two steps are involved in the classification process. It is necessary to determine the:

- Contaminant grade - based on the concentration of chemical contaminants.
- Stabilisation grade - based on the degree of reduction of pathogens, vector attraction and odour.

If assessments of the contaminant and/or stabilisation grades are not undertaken, the product remains sewage sludge, and is not suited for beneficial use within the scope of these Guidelines. However, advice may be obtained from EPA Tasmania regarding potential use of sewage sludge. Any such use will be subject to stringent conditions.

6.1Sewage Sludge and Biosolids Intended for Reprocessing

Sampling and classification requirements for sewage sludge or biosolids intended for reprocessing (e.g. composting) should be discussed with the EPA before the material is transported. The default position is that sewage sludge and biosolids must be classified in accordance with these guidelines unless the material is being sent to a facility authorised to accept sewage sludge.

7. Contaminants

The contaminants listed in these Guidelines are those that have been identified through international research, and historical monitoring of sewage sludge and biosolids produced in Tasmania as posing the highest risk.

Biosolids must also be free of physical contaminants, such as plastics, that could compromise the intended use.

7.1 Contaminants & Grading

7.1.1 Initial Contaminant Screening

Contaminant grading of biosolids occurs against thresholds established for up to eight metals. However, before proceeding with contaminant grading, the Producer must carry out a risk assessment of the relevant WWTP catchment to screen for industrial and commercial premises which may contribute elevated concentrations of contaminants to the sewer other than the eight metals listed in these Guidelines. Please refer to section 7.1.2 for specific guidance on identified synthetic compounds of concern.

The risk assessment should take into account the potential cumulative impact of multiple discharges into the sewer catchment. These contaminants may or may not already be identified by the Producer, for example, through any contract it holds with industrial and commercial trade waste generators. This process must be repeated should any significant changes occur to the catchment, such as the addition of a significant trade waste customer or during the shutdown phase of an industry.

The concentrations of any additional contaminants in the biosolids identified in this process must be established and compared to Table 2 in the *Information Bulletin 105: Classification and Management of Contaminated Soil for Disposal*. The Producer must consult with EPA Tasmania on how to deal with any biosolids containing a contaminant which exceeds the Level 1 Fill Material concentrations specified in IB 105, before commencing contaminant grading. If no contaminants exceed the Level 1 Fill Material concentrations in IB 105, contaminant grading may commence. The Producer must consult with EPA Tasmania if the contaminant is not listed in IB 105.

At a minimum, in the event no additional contaminants are identified from the sewer catchment assessment, initial screening should include the parameters included in Table 7.1. Sampling requirements are described in Appendix B.

7.1.2 Persistent Organic Pollutants

Perfluorinated alkylated substances (PFAS), specifically perfluorooctanesulfonic acid (PFOS), perfluorohexane sulfonate (PFHxS) and perfluorooctanoic acid (PFOA) have been identified through research as warranting specific monitoring in biosolids. These compounds are found in numerous industrial and consumer products, however it is the use of PFOS in flame-retardant foams used for firefighting which is likely to be the highest risk in terms of elevating concentrations in biosolids. Under the Stockholm Convention PFOS is listed for restricted production and PFOA is being considered for listing and, so over time, concentrations of these compounds in biosolids should decline, however they are persistent, toxic and bio-accumulative and so require specific attention.

Health based guidance values for PFAS have been recently reviewed by the Australian Government Department of Health. As these values are potentially subject to further modification it is not deemed appropriate to prescribe specific contaminant acceptance thresholds in these guidelines. However, given the paucity of information on concentrations of these compounds in Tasmanian biosolids it is deemed necessary to monitor, assess and, if necessary, determine appropriate management options for any biosolids containing sufficient concentrations of these compounds.

Significant potential sources of these contaminants include airports and industrial premises which need to manage a high fire risk, fire services training grounds and landfill leachate. If the WWTP is serving a larger urban catchment or a catchment containing any of these potential sources, the Producer must sample and analyse the biosolids for these contaminants in accordance with the sampling requirements specified in Appendix B. If found above reporting limits the Producer must provide this information to EPA Tasmania and discuss appropriate management options.

7.1.3 Contaminant Grading

Contaminant grading of biosolids is established by sampling the sewage sludge and determining the "Biosolids Adjusted Contaminant Concentration" (BACC) for each contaminant in the product (see Appendix C), and comparing these with the "Contaminant Acceptance Concentration Thresholds" listed in Table 7.1 to Grades A or B. The BACC must be below the numerical values stipulated in Table 7.1 for a grade to apply. If Grade B limits are exceeded the material is 'unclassified' and is considered to be sewage sludge (a Controlled Waste).

Table 7.1: Contaminant Acceptance Concentration Thresholds for Biosolids

CONTAMINANT	GRADE A (mg/kg dry weight)	GRADE B (mg/kg dry weight)
Arsenic	20	60
Cadmium	1	20
Chromium (total)	50	300
Copper	100	2,500
Lead	150	420
Mercury	1	15
Nickel	60	270
Zinc	200	2,500

The contaminant grade for a biosolid is determined by the lowest quality grade for any one contaminant. For example, if most of the contaminant concentrations in a biosolid pass Contaminant Grade A, but one contaminant is Contaminant Grade B, the entire product is classified as Contaminant Grade B.

Material containing sewage sludge is assumed to be unclassified and a Controlled Waste until proven otherwise.

7.1.4 Minimum Routine Contaminant Parameters

If *continuous* sampling mode is adopted (see Appendix B) it may be possible to reduce the suite of contaminants further once the initial screening process has been completed. If the screening process demonstrates arsenic, lead, mercury and nickel are present at less than 50% of the target concentration for the end use of the biosolids, analysis can be dropped from future sampling with the proviso that the full screening is repeated:

- annually; and
- whenever there is a reason to expect change in the composition of the influent to the WWTP, such as may occur with the connection of a new industry to the sewer.

Table 7.2 contains the minimum parameter suite for biosolids which must always be tested. These parameters were identified by the National Biosolids Research Program as those most likely to affect food quality, crop production and soil health. Analysis of these parameters is required for calculation of the Contaminant Limiting Application Rate (see Appendix D).

Table 7.2: Minimum Contaminant Suite for Biosolids Classification

CONTAMINANT	GRADE A (mg/kg dry weight)	GRADE B (mg/kg dry weight)
Cadmium	1	20
Chromium (total)	50	300
Copper	100	2,500
Zinc	200	2,500

A contaminant grade may be improved by blending with other acceptable materials such as other biosolids, composted green waste, lime or other by-products. The blended product must be re-sampled, analysed and re-graded in accordance with these Guidelines to determine the new contaminant grade.

8. Stabilisation

In order to address health and nuisance odour risks, sewage sludge must be treated, or "stabilised" to an appropriate standard before reuse. Stabilisation means the processing of biosolids to reduce, or eliminate the potential for putrefaction, and thus reduce pathogens, vector attraction and offensive odours. A vector is any insect or animal, such as flies, mosquitoes, birds and rodents which are attracted to the putrescible organic matter in biosolids and which may spread pathogens.

Stabilisation requirements fall into three categories, all of which must be met:

- Biosolids must not exhibit a strong, offensive odour
- An approved vector attraction reduction requirement must be met; and
- The pathogen reduction criteria must be achieved for the intended end use.

Consideration of the three stabilisation requirements results in biosolids falling into stabilisation Grade A or B. Any sewage sludge which cannot meet Grade A or B requirements is unclassified and not suitable for beneficial use.

Odour and Vector Attraction Reduction requirements are the same for Stabilisation Grade A and B. For pathogen reduction requirements, there are two levels of microbiological standard and acceptable treatment processes which distinguish Stabilisation Grade A and B. Other treatment processes can be used provided the achievement of the required vector attraction reduction and microbiological standards can be verified.

Producers or Reprocessors are required, for all processes treating biosolids for beneficial use, to implement a period of process verification (see Section 8.4) to demonstrate compliance with stabilisation requirements.

Details of sampling requirements for verification and routine analysis is presented in Appendix B.

8.1 Odour

Adequately stabilised biosolids should not exhibit strong, offensive odour. Biosolids giving off strong, offensive odour should not be sent for beneficial use. While odour is subjective, if there is doubt, the material should be subjected to further treatment or diverted to a facility authorised to accept sewage sludge.

8.2 Vector Attraction

The Producer or Reprocessor must be able to demonstrate that one of the Vector Attraction Reduction requirements (Table 8.1) has been met.

Table 8.1: Approved Processes for Vector Attraction Reduction[1]

Option	Vector Attraction Reduction Options	Biosolids Most Suited
1	Biosolids treatment process reduces volatile solids by ≥38%	All biological anaerobic or aerobic processes. This is what can be achieved in a completely mixed high-rate anaerobic digester treating raw sludge at 35°C in 15 days.
2	<17% additional volatile solids loss during bench-scale anaerobic batch digestion of sludge for 40 additional days at 30-37°C	Only anaerobically digested sludge that cannot demonstrate Option 1.
3	<15% additional volatile solids reduction during bench-scale aerobic batch digestion for 30 additional days at 20°C.	Only aerobically digested liquid sludge (≤2% solids) that cannot demonstrate Option 1 e.g. extended aeration WWTPs
4	Biosolids containing stabilised solids only, dried to ≥75% solids content	Fully stabilised by anaerobic or aerobic process
5	Biosolids containing un-stabilised solids, dried to ≥ 90% solids content	Heat dried biosolids
6	Aerobic treatment for ≥ 14 days at a minimum temperature of 40°C and an average temperature >45°C	Composted biosolids
7	Biosolids pH raised to ≥12, and without addition of further alkali, pH maintained at ≥12 for 5 days	Alkali treated biosolids
8	Injection or incorporation of biosolids on same day as application	Class 2 Biosolids only
9	Other methods demonstrating minimum re-growth potential verified by an approved testing regime	Biosolids which do not satisfy any of the other options above.

8.3 Microbiological Standards and Stabilisation Grading

8.3.1 Stabilisation Grade A Product

Stabilisation Grade A products must meet the microbiological standards in Table 8.2 and at least one of the vector attraction reduction requirements listed in Table 8.1. Stabilisation Grade A pathogen reduction must be accomplished before, or at the same time as, one of the vector attraction reduction requirements to prevent pathogen regrowth. The microbiological standards for Grade A (Table 8.2) are necessarily stringent and every sample must comply with these numerical requirements (not on average) with the exception of *E. coli* to which a 90th percentile limit applies.

[1] Adapted from US Regulation 40 CFR Part 503 (US EPA Environmental Regulation & Technology: Control of Pathogens and Vector Attraction in Sewage Sludge, EPA/625/R-92/013) and NWQMS Guidelines for Sewerage Systems (Biosolids Management), 2004

Table 8.2: Microbiological Criteria Stabilisation Grade A

Microbiological Criteria (based on dry weight of product)	Monitoring Requirements
< 100 *E. coli* CFU (or MPN) per gram (90th percentile limit)	Initial verification and routine
Salmonella spp. not detected in 50 grams (maximum limit)	Initial verification
< 1 Enteric virus PFU per 50 grams maximum limit)	Initial verification
<1 viable helminth ova (*Taenia* spp) per 50 gram (maximum limit)	Initial verification

CFU = colony forming unit, MPN = most probable number, PFU = plaque forming unit

Table 8.3 presents a description of recognised treatment processes which can achieve Stabilisation Grade A.

Table 8.3: Approved Processes to achieve Stabilisation Grade A

Approved Process	Conditions
Composting by static aerated pile or in-vessel	The temperature of all the compost material is to be maintained >55°C for 3 continuous days.
Composting by windrow	Temperature of all of the compost material is to be maintained >55°C for 15 days or longer and the windrow must be turned at least 5 times in accordance with AS 4454:2012, Section 3.2.1 Pasteurisation
Lime stabilisation with heating	pH of all the biosolids product to be raised above 12 and pH to remain >12 for a minimum of 72 continuous hours. During this 72hr period the temperature must be >52°C for a minimum of 12 continuous hours or meet the pasteurisation criteria of 70°C for 30 minutes. At the end of the 72hr period product to be dried to solids content >50% by weight.
Heating and drying	Biosolids dried by heating particles to >80°C to achieve a final solids content of at least 90% by weight. Final product to be kept dry until applied.
Thermally treated biosolids	Biosolids are dewatered to >7% solids with a temperature of at least 50°C for D days. Calculation of the minimum time required to achieve Stabilisation Grade A can be made using $D = (131{,}700{,}000)/(10^{0.14t})$ where D is the time in days and t is the temperature in degrees Celsius.
Other processes	Which meet microbiological criteria in table 8.2 and vector attractant reduction criteria in Table 8.1. Please refer to the US Regulation 40 CFR Part 503 for guidance.

8.3.2 Stabilisation Grade B Product

Stabilisation Grade B products must meet the vector attraction reduction requirements listed in Table 8.1 and the microbiological standard detailed in Table 8.4. Table 8.5 details treatment processes which can achieve Stabilisation Grade B, noting the requirement to provide microbiological results to verify and monitor the ongoing performance of the treatment process.

Table 8.4: Microbiological criterion Stabilisation Grade B

Microbiological Criteria (based on dry weight of product)	Monitoring Requirements
<2,000,000 *E. coli* CFU (or MPN) per gram (geometric mean of at least 7 sample results)	Initial verification and routine

Table 8.5 presents a description of recognised treatment processes which can achieve Stabilisation Grade B.

Table 8.5: Approved Processes to Achieve Stabilisation Grade B

Approved Process	Conditions
Anaerobic Digestion	Mean temperature must be maintained at 35 - 55°C for >15 days, or 15°C for >180 days.
Aerobic Digestion	Sludge is agitated with air or oxygen to maintain aerobic conditions for a minimum of 40 days at 20°C or 60 days at 15°C.
Composting by windrow, static aerated pile or in vessel methods	Temperature must be maintained >40°C for a minimum of 5 days. For 4 hours during the 5-day period the temperature must be >55°C. Aerobic conditions must be maintained.
Lime Stabilisation	pH of all the biosolids product to be raised above 12 and pH to remain >12 for a minimum of 5 days (this is equivalent to vector attraction option 7).

8.4 Process Verification for Stabilisation

Process verification is required for all WWTPs and reprocessing facilities for which the biosolids produced are intended for beneficial use. Process verification is required to demonstrate the sewage sludge treatment process is effective in the following circumstances:

- Any new facility, or any facility where verification has not previously been carried out;
- Any non-approved stabilisation treatment process; or
- Whenever there is a significant change to facility inputs (e.g. changes to treatment process, major increase to WWTP loadings).

For Stabilisation Grade A biosolids, process verification must be repeated annually.

8.4.1 Verification Requirements

Verification of the stabilisation process must be demonstrated prior to any biosolids being beneficially used. Therefore, the sampling frequency during this phase will be dependent on the quantity of biosolid being produced and logistical considerations such as on-site storage. A default minimum of 7 samples is required to indicate compliance with any specific vector attraction reduction process, such as volatile solids reduction, for continuous production WWTPs. A lower sample number requirement may be appropriate for WWTPs which produce small quantities of Class B biosolids in a batch process.

The Producer or Reprocessor must be able to provide the following information:

- Evidence that the process achieves vector attraction reduction requirements (Table 8.1);
- Test results from a suitably accredited laboratory showing compliance with maximum pathogen levels for Stabilisation Grade A (Table 8.2) or Stabilisation Grade B (Table 8.4); and
- Measurement of relevant process criteria (e.g. retention times/reaction times/temperature/pH/moisture/other process controls) to ensure compliance with designated stabilisation process.

The Producer or Reprocessor must produce a report demonstrating these requirements have been met for the appropriate Regulator to assess.

9. Biosolids Classification & Allowable End Uses

Once the Contaminant and Stabilisation Grades for a biosolid have been established the overall Biosolids Classification and suitable reuse options can be determined as shown in Table 9.1.

The classification of biosolids is determined by the lowest grading e.g. if a product achieves Contaminant Grade A and Stabilisation Grade B, or Contaminant Grade B and Stabilisation Grade A, it is a Class 2 product.

To be classified as a Biosolid, sewage sludge must have:

- undergone the sampling, analysis and grading requirements detailed in Section 7, Appendix B and Appendix C and, as a minimum, met Contaminant Grade B requirements; and
- met the treatment, sampling and analysis requirements detailed in Section 8 and Appendix B and, as a minimum met Stabilisation Grade B requirements.

A Class 1 biosolid can be used for any of the Allowable End Uses listed, but a Class 2 biosolid cannot be used for an Allowable End Use listed for Class 1 biosolids.

Liquid biosolids cannot be Class 1 biosolids, even if the contaminant and stabilisation grades are both Grade A.

Please see Section 10 below for more detail on the end use categories and requirements.

Table 9.1 Classification of Biosolids and Allowable End Uses

Classification	Contaminant Grade	Stabilisation Grade	Allowable End Use	Additional Requirements
Class 1 Biosolid	A	A	Home garden (retail sale). Urban landscaping	Labelling (see section 10.1 below)
Class 2 Biosolid	A	B	Site Rehabilitation Agriculture Forestry Composting	Demonstrate application is below NLAR. LUPAA permit may be required, contact Local Government.
	B	A		
	B	B		
Sewage Sludge	A or B	unclassified	EPA approved licensed facility (landfill and reprocessing facilities)	Sewage sludge is a Controlled Waste and therefore subject to legislated requirements.
	unclassified	A or B		
	unclassified	unclassified		

9.1 Reclassification of Biosolids

Biosolids can be blended with other acceptable materials or further treated to improve classification and/or produce a material with more desirable properties. However, the altered product must be re-sampled, analysed and reclassified in accordance with these Guidelines to determine the new biosolids classification.

9.2 Compost Containing Sewage Sludge or Biosolids Intended for Home Use or Urban Landscaping

In accordance with AS 4454-2012 *Composts, Soil Conditioners and Mulches Section 2 General Requirements-Containment of (Human, Animal and Plant) Disease subsection 2.1* any material containing reprocessed biosolids intended for unrestricted use (i.e. Class 1 Biosolids) "must comply with the chemical, physical, organic and pathogen contaminant requirements" of any applicable federal and state or territory guidelines and regulations for land application of products derived from biosolids or AS 4454:2012, "whichever is the most restrictive".

10. Allowable End Uses of Biosolids

10.1 Home Garden

Only Class 1 biosolids products are permitted for use in the home garden. These may include reprocessed biosolids in the form of compost. The following information must be provided by the supplier, and if bagged, this information must be contained on each bag label:

- Advice that the product contains biosolids;
- Directions for the safe use and handling of the product in accordance with AS 4454:2012 section 5.2, including the *Health Warning Label* as specified; and
- Advice on application on areas for vegetable production – specifically leafy vegetables, root and tubers.

10.2 Urban Landscaping

Only Class 1 biosolids products are permitted for use in urban landscaping. Urban landscaping covers uses in publicly accessible areas (excluding domestic gardens) such as parks, sports grounds and roadside verges and includes privately owned land which opens to the public e.g. golf courses. The supplier is required to supply the same information on the product as for Home Garden Use. The end user is not required to maintain records for urban landscaping unless specifically requested by the Regulator (EPA or Local Government). The Regulator may impose specific restrictions depending on the level of public access to the area receiving the biosolids. Urban Landscaping is classed as 'Land Application'. Section 11 details relevant site restrictions.

10.3 Agriculture

10.3.1 Farm Management Plans

It is strongly recommended that agricultural End Users, particularly those who accept biosolids on a regular basis, develop a Farm Management Plan to holistically consider biosolids applications in the context of crop requirements, factoring in the various constituents and properties of the biosolids being applied and what other agronomic inputs will be required. This will help ensure the maximum agronomic and economic benefits are achieved, minimise the potential for over application and off-site migration of nutrients and the plan will ensure the end user has a record of where, when and how much biosolids have been applied.

10.3.2 Restrictions

Restrictions are imposed on specific groups of crops to minimise the risk of pathogen exposure when using Class 2 biosolids in agriculture. Table 10.1 provides minimum crop withholding periods to be adhered to following an application of Class 2 Biosolids. Please note however, specific advice should be sought through supplier agreements on product restrictions, particularly in respect to human food crops prior to land applying biosolids.

These recommended restrictions are consistent with other requirements for managing pathogen risks to livestock such as bovine spongiform encephalopathy (BSE) and scrapie. Composting in accordance with AS 4454:2012 does not reduce the potential risk from prions causing these diseases (Animal Health Australia, 2017) and so to best manage this, biosolids are assumed to potentially contain restricted animal material (RAM).

Table 10.1 Minimum Crop Restrictions for Class 2 Biosolids Applications

Crop	Restriction
Human Food Crops[2]	For crops which may be eaten raw, and where harvested parts are close to the soil surface (e.g. lettuce), planting must be delayed for 18 months after biosolids application. For crops which may be eaten raw, and where harvested parts are below the soil surface (e.g. carrots, potatoes), planting must be delayed for 5 years after biosolids application. In all other cases, (i.e. food crops where the harvested product is not in contact with the ground such as apples and wheat) the crop must not be harvested for 30 days after biosolids application. Windfalls (e.g. orchards) must not be collected for 12 months after the biosolids application, unless further processing involving pasteurisation (e.g. canned fruit) occurs.
Animal Feed and Fibre Crops	Must not be harvested for 30 days after biosolids application
Pasture and Fodder crops	Animals must not have access to stockpiles of biosolids. Animals must not have access to or be grazed on the site for at least 30 days after biosolids application. Poultry, pigs and other rooting livestock must not be grazed on biosolids application or storage areas as feeding habits of these animals can result in high levels of soil ingestion. Exclusion is preferable but a withholding period of at least 3 years applies. The Producer must maintain a register of all properties which apply biosolids to grazing land or produce animal fodder for cattle and make this register available to the Chief Veterinary Officer on request.
Turf	Turf grown on land to which biosolids has been applied must not be harvested for 12 months after biosolids application.

10.4 Forestry

Biosolids applications to plantations have similar value to agriculture both as a fertiliser and soil conditioner. Crop requirements for nitrogen in the initial few years is relatively low, but increases after year 2. It should be noted high nutrient levels can induce form defects in plantation trees and application rates for nitrogen and phosphorus should consider this potential decrease in merchantability against increase in growth rates. Site restrictions for slopes and rocky ground that apply for other beneficial uses may be relaxed with adequate management measures in place (see Table 11.1).

10.5 Site Rehabilitation & Landfill Cover

Site-specific requirements will be in place for most rehabilitation and landfill sites. The appropriate Regulator (EPA or Local Government) must be consulted for any site-specific requirements or to confirm whether any further approval is required.

10.6 Other Uses

Other proposed uses, such as energy generation or incorporation of biosolids into building products, will be considered on an individual basis by the EPA.

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[2] End users must seek relevant advice on specific food crop restrictions

11. Site Selection for Land Application

This section is relevant for all land application of biosolids including forestry, site rehabilitation, and agricultural use.

Public access to sites which have received Land Application of Class 2 Biosolids must be restricted for at least 30 days or until vegetation is re-established. Signage advising the public of the use of biosolids products must be placed on gates and other points of access.

Selection of an appropriate site for a biosolids application is critical for success. Some of the problems that can arise with poorly selected or managed biosolids application sites include runoff into streams or dams, infiltration of nitrates into groundwater, transmission of disease to livestock, odour nuisance to neighbours.

The land use of the application site and neighbouring properties is an important consideration as is the soil and landform characteristics of an application site. Selection of a good site can prevent onerous management requirements and reduce risk of public complaint.

When selecting an application site, the End User should ideally avoid sites in close proximity to sensitive areas such as those of ecological, natural, cultural or heritage value and areas with a high level of public access or in proximity to residential property.

11.1 Physical Site Characteristics

Land capability factors such as soil types, slope, groundwater depth, rainfall must also be considered.

Table 11.1 details the default physical site characteristics which restrict Class 2 biosolid applications.

Table 11.1 Physical Site Restrictions

Site Characteristics	Restriction		Additional information
Slope	<15% (<1:7 ratio)		To prevent run-off and erosion. Forestry and site rehabilitation are possible exceptions, with management controls this can be increased to <25%
Buffer Distances	Open watercourse downslope	>100m	Buffer zones are used to reduce the likelihood of run-off, dust or odour affecting adjacent land or watercourses
	Open watercourse flat	>50m	
	Open Watercourse upslope	>10m	
	Occupied dwellings	>100m	
	Residential zones	>250m	
	Public roads and adjoining properties	>50m	
	Water bores	>50m (>250m if drinking water bore)	
	Native forests or significant vegetation	>10m	
	Property access roads	>5m	
Soil pH	>4.5		This restriction does not apply to lime amended biosolids.
	<7.5 (<7)		<7 applies to lime amended biosolids only.
Undesirable Drainage	Waterlogged, flood prone or extremely permeable soils		To prevent run-off or groundwater contamination
Shallow Groundwater	>1.5m to groundwater		Biosolids must never be applied to land with a water table less than 1.5m below the ground. Soil clay content in top metre influences further restrictions.
	Average Clay % (0-100cm)	Minimum depth to groundwater	
	>35%	1.5m	
	25-35%	2m	
	15-25%	3m	
	10-15%	4m	
	5-10%	5m	
	<5%	8m	
Rocky ground	Untillable land		Forestry and site rehabilitation are possible exceptions with management controls in place. Discuss with appropriate regulatory agency.

11.2 Management Controls

This section details site management practices to be upheld when using biosolids for land application. If adhered to these management controls, coupled with the site restrictions described in section 11.1 above, will minimise risks of environmental nuisance or harm.

Table 11.2 Management Controls

Practice	Management
Signage	Any area used for stockpiling or biosolids application must have adequate signage installed on appropriate gates and fence lines to ensure the public is aware of the risk and prevent public accessing the area. Advice on appropriate signage may be obtained from Public and Environmental Health Services.
Stockpiling dewatered biosolids on application sites	If possible, biosolids should be stored at the biosolids production or processing site rather than the application site. If it is necessary to store dewatered biosolids at the application site: • stockpile areas should be located on the minimum slope possible within the application area but away from any area subject to flooding. • stockpile to be located at least 100m from nearest property boundary. • stockpile must not be accessible to livestock. • stockpile must not to be subject to erosion by wind or rain – if this is found to be occurring biosolids must be applied or erosion addressed. • stockpiling is limited to the day of application for biosolids specifically requiring incorporation to meet vector attraction reduction requirements (Table 8.1). • biosolids to be stored on site for more than 24 hours must either be: o retained within a bunded storage area constructed and maintained to contain the first hour of a 1 in 20-year rainfall event; or o on a site where it can be reasonably demonstrated that surface run-off or groundwater leaching will not be problematic. • To ensure excessive quantities of biosolids do not accumulate on an application site, biosolids should not be stored for more than 90 days. An exception may be made during winter months on the proviso that the biosolids are stored within a bund and those biosolids must be used in the upcoming growing season. • For bunded storage areas: o surface water diversion is required to prevent entry of overland flow into the bunded area, and o a drainage collection point should be located within the bund, but separated from the stored biosolids, and collected drainage should be applied to the application site.
Incorporation of biosolids	Biosolids should be incorporated whenever possible (e.g. applied to land about to be cultivated, or direct injected as a liquid). However, many forms of biosolids (e.g. dried, lime amended) are suited to surface application without incorporation, and management practices (e.g. biosolids treatment, withholding periods, buffer zones) can be used to minimise the risk of off-site impacts and vector attraction. In all cases, reasonable judgement should be exercised with respect to the appropriate application and incorporation requirements for the biosolids and site in question.
Repeat application and soil pH adjustment	Following application soil pH should be maintained above pH 5.5 to minimise migration of nutrients and contaminants into groundwater. Prior to repeat biosolids applications soil sampling must be completed to verify soil pH.
Liquid biosolid applications	Pooling and runoff of liquid biosolids after application is to be avoided.
Weather patterns and seasonality	All biosolids applications should be scheduled to take into account preceding, present and forecast weather conditions, with particular emphasis on avoiding likely rainfall events. Consideration should be given to whether wind conditions will increase the likelihood of dust and odour being carried beyond buffer zones. Winter application of biosolids should be avoided where possible due to low nutrient uptake.

12. Application Rates

Under most land application uses biosolid application rates must not exceed the nitrogen demand of the crop. The available nitrogen in the biosolids must be determined to calculate the appropriate application rate. Similarly soil and biosolid contaminant levels need to be considered when calculating appropriate application rates. These can be affected by soil properties such as pH, clay content and cation exchange capacity. These application rates are referred to as the Nitrogen Limiting Application Rate (NLAR) and the Contaminant Limiting Application Rate (CLAR).

When these values are assessed the lowest application rate is the restricting value and is therefore the appropriate application rate to be used. This application rate is referred to as the Maximum Allowable Biosolids Application Rate (MABAR). To comply with these guidelines any biosolids reuse application must not exceed the MABAR.

The AMM, section 3.5 allows a low rate application of Class 2 biosolids to occur without the need to determine the CLAR. A low rate application is defined by being less than 50 per cent of the NLAR followed by a 3-year period where no repeat application of biosolids may occur on that land.

Please refer to Appendix B for soil sampling and analysis requirements and Appendix D for calculation methods for Nitrogen and Contaminant Limiting Application Rates. Appendix F provides a worked example of the calculations which must be completed.

13. Record Keeping

The Producer or, if appropriate, the Reprocessor must retain all records of analysis and associated documentation that have been used to classify the biosolids for at least 5 years. Likewise, if appropriate, records of the location of the properties supplied with Class 2 biosolids, the quantities supplied, the date of supply, the paddocks on which they were applied and all information to verify the application rates should also be maintained for at least 5 years.

The End User must maintain records of the dates of biosolids applications, the application rate and the subsequent uses of the application area.

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Appendix A: Statutory Framework

Other Relevant Legislation

In addition to environmental legislation, there are other legislative requirements which apply to the safe handling and management of sewage sludge and biosolids in Tasmania.

Work Health and Safety Act 2012 is the principle Tasmanian legislation in place to provide for the health and safety of people employed, engaged or affected by industry.

The *Animal Health Act 1995* is the Tasmanian legislation relevant to animal health and provides a basis regarding the monitoring requirements and restrictions imposed regarding livestock exposed to biosolids.

The *Public Health Act 1997* is the Tasmanian legislation in place to protect human health and reduce the incidence of preventable illness.

Primary Produce Safety Act 2011 is Tasmanian legislation to allow the application of the Australia New Zealand Food Standards Code to primary production activities.

The Australia New Zealand Food Standards Code developed under the *Food Standards Australia New Zealand Act 1991* specifies 'Maximum Levels' (ML) and 'Maximum Residue Limits' (MRL) permitted to be present in food. MRLs normally apply to agricultural and veterinary chemicals whilst MLs apply to metal and non-metal contaminants and natural toxicants.

Appendix B: Sampling Guide

General

This Appendix gives an overview of the sampling requirements and considerations for biosolids classification and land application. Representative samples of the biosolid must be tested to demonstrate contaminant grade, stabilisation grade and nutrient concentrations. Representative samples of the soil on the reuse site must be tested to determine site suitability and to calculate appropriate application rate. Sampling requirements differ for biosolids contaminants, for biosolids stabilisation, biosolids nutrients and for soil analysis. This appendix clarifies these requirements.

All sampling must be carried out by suitably skilled personnel and in accordance with standard sample collection and preservation methods. All analyses should be conducted by laboratories with appropriate certification (e.g. National Association of Testing Authorities (NATA) accreditation) for the required tests.

An overview of the sampling requirements is provided in Tables B1 and B2 at the end of this appendix.

Representative Sampling

Any sample taken for analysis should be representative of the total quantity of material being classified. Factors such as surface drying or wetting of biosolids stockpiles or mixing with soil or other products can give variability throughout a batch of biosolids.

Sampling of biosolids and soil should be carried out in a manner which demonstrates that the material gathered is representative of the whole.

When to Sample

Biosolids should be sampled when they are in the condition intended for final use, prior to being removed from the WWTP and as close as possible to the time of use. For analysis purposes biosolid samples need to be a minimum of 5% solids.

Soil can be sampled at any time prior taking into account sampling notes made in the relevant section below.

Sample Collection and Storage

When developing a sampling plan, it is important to be cognisant of specific sampling handling requirements and holding times. These issues should be discussed with laboratory staff before sampling occurs.

A useful reference document for sampling guidance for biosolids contaminants and soils is *AS 4482.1-2005 Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi volatile compounds*.

Biosolids Contaminant Sampling

A Producer must determine the most appropriate sampling regime for biosolids and the appropriate sampling frequency. Sampling can be made on a continuous or batch basis.

The key distinction is that for *continuous* sampling a rolling sampling and analysis regime is adopted taking into account past sample results. *Batch* sampling is where samples are collected from discrete batches and classification determined for each batch.

The *Continuous* sampling regime requires sampling to initially occur at the high sampling frequency until biosolids classification is determined. At this point sampling frequency can drop to the low frequency sampling rate, unless there are concerns regarding contaminant levels or variability found in the biosolids.

Under a *Batch* sampling regime, the low sample frequency is adequate with a proviso that a minimum of 3 composite samples are analysed per batch.

Under either sampling regime the Producer must ensure Section 7.1.1 Initial Contaminant Screening has been adequately addressed including initial analysis of a broader suite of parameters. At a minimum this includes all parameters listed in column 1 of Table B1 (below).

Sample Collection

Biosolids contaminant concentrations are to be established using composite samples. Composite samples are obtained by combining a number of individual grab samples and can be collected in either a batch or continuous mode. Sampling strategies are illustrated in figures B1 and B2.

Sampling techniques should be constant for all samples and should not vary over time or between batches for each of the individual grab samples. While a minimum of four individual grab samples is required to form a composite sample, more can be taken, provided the number of individual grab samples combined to form a composite sample is consistent for all sampling occasions and all batches.

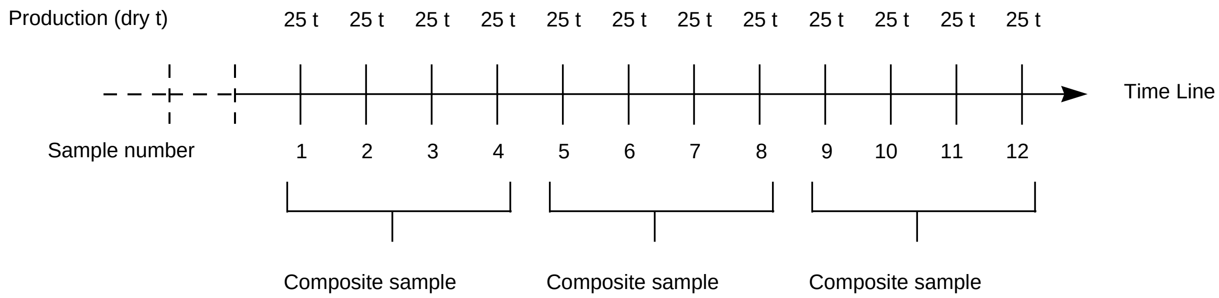


Figure B1: Continuous Sampling

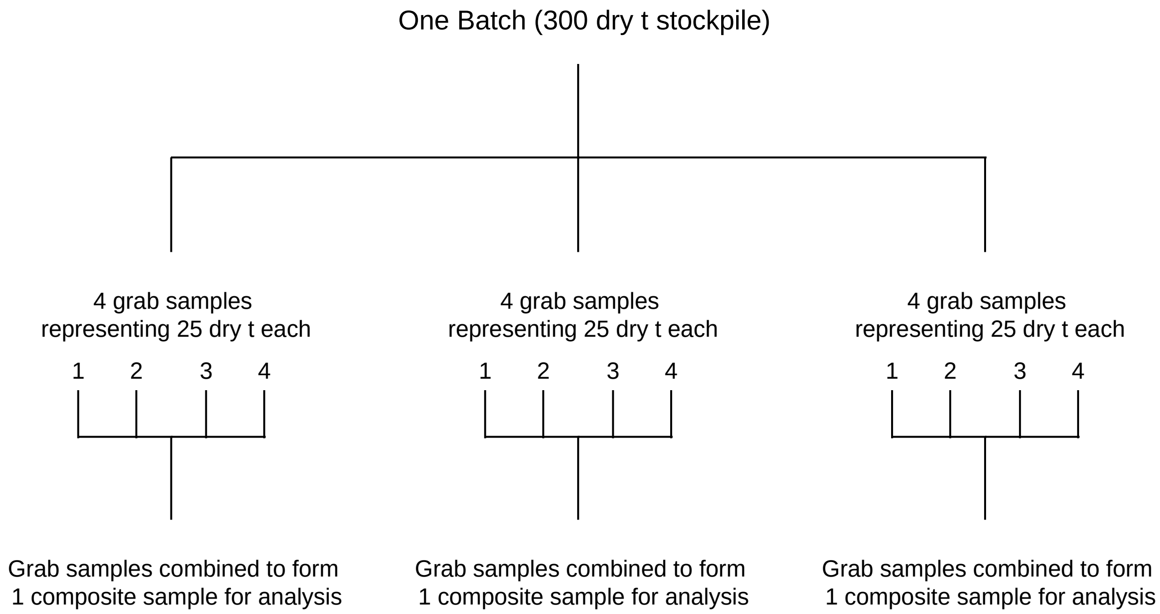


Figure B2: Batch Sampling

Sample Frequency

High frequency sampling (1 composite sample per 50 dry solid tonne (dst) biosolids)

High frequency sampling is used in the following situations:

Continuous sampling regime: at the start of a sampling program, when a minimum of 12 analyses is required to provide confidence on the contaminant grading and to provide baseline date for future comparison.

Variability in contaminant concentration: The Producer should use high frequency sampling if they notice that biosolids quality is variable, and particularly if the actual contaminant concentrations are around 80% of the Contaminant Acceptance Concentration Threshold (Table 7.1) to be achieved. This may allow producers to identify problems in the influent or treatment process and enable corrective action.

Low frequency sampling (1 composite sample per 100 dry solid tonne (dst) biosolids)

Low frequency sampling is used in following situations:

- Low frequency sampling is used for batch sampling regime where representative samples are collected from the entire consignment of biosolids leaving the WWTP. Note a minimum of 3 composite sample results is required for each batch to establish contaminant grade for batch processes.
- Low frequency sampling can also be used for routine analysis for the continuous sampling regime once the minimum 12 analyses have been obtained.

Determination of Contaminant Grade

Once sufficient sample results are obtained the Biosolids Adjusted Contaminant Concentration (BACC) must be calculated using the equations in Appendix C to determine the overall Contaminant Grade of the biosolids.

Biosolids Nutrients

The samples of sewage sludge collected for contaminants analysis should also be used to determine nutrient concentrations (see Table B1).

Stabilisation Sampling

As described in Section 8 there are two stages of sampling and monitoring for stabilisation demonstration, an initial process verification phase before moving into routine monitoring.

Microbiological and vector attraction reduction sampling requirements differ from those for contaminants grading. Samples must be collected as grab samples, not composite, for all stabilisation-testing requirements.

Microbiological Sampling

Microbiological sampling must occur before or at the same time as vector attraction reduction is achieved to prevent pathogen regrowth. Microbiological analysis requirements often stipulate a short holding time and this should be clarified with the laboratory prior to sample collection to ensure this can be met.

Sampling for Percentage Volatile Solids Reduction

To demonstrate volatile solids reduction samples need to be collected from the point sewage enters a sludge treatment process and at the end point of treatment. It is important that samples of sludge collected from within lagoons are representative of all the sludge to be removed i.e. samples are collected across the entire lagoon. Collection of samples from the starting point of the treatment process can be slow and difficult in some WWTPs however, as biosolids which have not achieved at least 38% reduction have the potential to be odorous, if this is the option proposed to demonstrate vector attractant reduction, it is important that fulfilment of this criterion can be demonstrated. If this is problematic it is recommended in these circumstances to refer to *US EPA Environmental Regulation & Technology: Control of Pathogens and Vector Attraction in Sewage Sludge, EPA/625/R-92/013* for details on bench scale batch digestion tests which can be performed on the product, as an alternative, to demonstrate acceptable volatile solids reduction.

Process Verification Monitoring

Before biosolids can be approved for reuse a period of monitoring is required to demonstrate stabilisation requirements have been met.

Monitoring of relevant process criteria such as retention times, reaction times, temperature, pH, moisture, or other process controls must be undertaken at appropriate intervals to give statistical confidence that the process is in control. This will vary on the type of process used, the volumes of biosolid being produced, the variability in the results obtained, and the stabilisation grade that is to be met.

Similarly, the appropriate frequency of monitoring to confirm vector attractant requirements will vary and, if necessary, the producer should discuss an appropriate monitoring regime with the EPA. As the geometric mean is used to establish compliance with vector attraction numerical requirements, a default of seven results should be presented to verify achievement of vector attraction reduction criteria options such as volatile solids reduction, additional volatile solids loss.

Stabilisation Grade A

During the verification phase microbiological sampling is to occur as a minimum at the high sampling frequency of 1 sample per 50 dry solid tonnes until 10 consecutive samples individually comply with the Microbiological Criteria in Table 8.2.

Stabilisation Grade B

During the verification phase microbiological sampling is to occur as a minimum at the high sampling frequency of 1 sample per 50 dry solid tonnes until 7 consecutive samples are available to demonstrate compliance with the Microbiological Criteria in Table 8.4.

Soil Sample Collection

Tests are required to determine the pH of soil and to check whether certain contaminants are present or nutrients are required. Soils often vary considerably in chemical and physical composition over short distances, even in paddocks of apparently uniform soil. Representative soil samples are obtained by mixing soil from a sufficiently large number of locations in the paddock. The more locations sampled, the more reliable the analysis.

Use the following guidelines to obtain representative soil samples and prepare them for analysis:

- Avoid sampling excessive amounts of plant material with soil.
- Separate composite samples must be collected for different soil types, areas cropped or fertilised differently and for each paddock.
- Samples should not be taken from areas fertilised or limed within the previous three months.
- Avoid patches of very good growth, stock camps, fence lines, dam and trough surrounds and burnt areas (such as windrows).
- Each composite sample should represent not more than 20 hectares. Larger areas should be subdivided and two or more samples submitted.
- Each composite sample should be a mixture of soil from at least 30 to 40 locations taken in an even zig-zag distribution across the sample area.
- Take samples using a tube sampler or spade, but not a soil auger. If a spade is used, dig a small hole with a vertical side and take a slice of soil about 20 mm thick from the top 100mm of soil as a minimum
- Always check with the laboratory on the requirements for sample collection: sample size, sample containers, labelling, storage and transport of samples.
- Laboratory analysis generally requires 0.5 – 1.0 kg for each composite sample.

Analysis Requirements

Table B.1: Summary of Biosolids Analysis Requirements

Parameter	Unit
Moisture content	(%)
Contaminant Grade	
Total Arsenic	mg/kg (DMB)
Total Cadmium	mg/kg (DMB)
Total Chromium	mg/kg (DMB)
Total Copper	mg/kg (DMB)
Total Lead	mg/kg (DMB)
Total Mercury	mg/kg (DMB)
Total Nickel	mg/kg (DMB)
Total Zinc	mg/kg (DMB)
Nutrients	
Ammonia N	mg/kg (DMB)
Nitrate/Nitrite (Oxidised N)	mg/kg (DMB)
Total Kjeldahl Nitrogen	mg/kg (DMB)
Total Nitrogen	mg/kg (DMB)
Persistent Organic Contaminants (Large urban WWTPs or WWTPs receiving wastewater from airports/landfill leachate)	
PFOS	mg/kg (DMB)
PFHxS	mg/kg (DMB)
PFOA	mg/kg (DMB)
Stabilisation Grade	
E. coli	CFU (or MPN) per gram
Salmonella	CFU per 50g
Enteric viruses	PFU per 50g
Helminth Ova (*Taenia* spp)	Number of ova per 50g
Vector Attractant (as appropriate)	
Total solids	g/kg
Total Volatile Solids	g/kg
pH	pH units

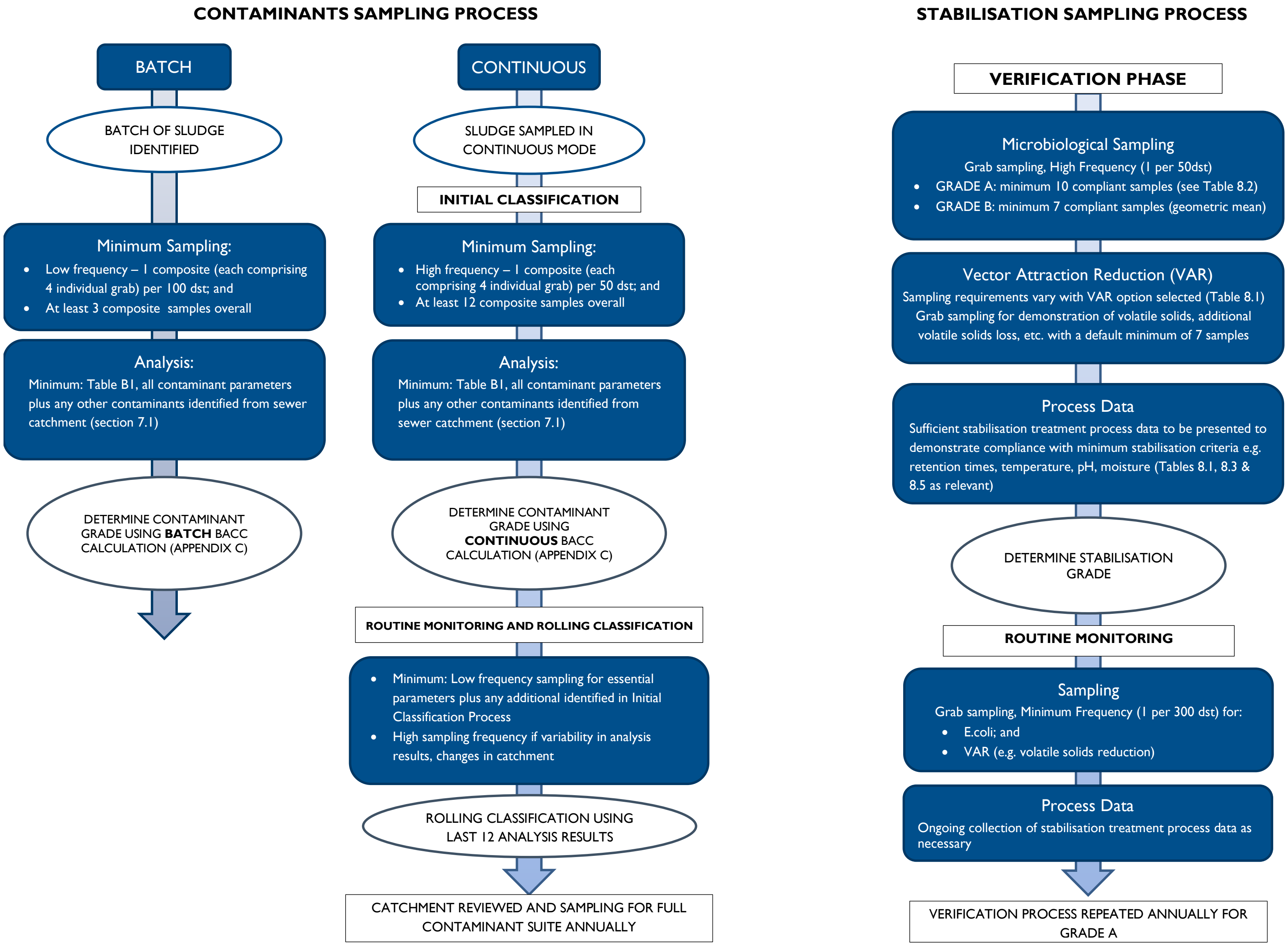
PFAS Analysis

The analysis of biosolids for PFAS may be complicated by the presence of "precursor" PFAS compounds which may not be detectable by normal laboratory procedures, but which can transform in the environment to PFOS or PFOA. Total Oxidizable Precursor Assay (TOPA) or TOF (Total Organic Fluorine) analyses may be used to quantify the total PFAS content. When used in conjunction with the available suite of individual PFAS compounds, they provide an indication of the possible magnitude of precursors. To ensure the appropriate analysis is conducted it is recommended this is discussed with the laboratory conducting the analysis prior to sampling.

Table B.2: Summary of Soils Analysis Requirements

Soil Sampling Requirements	
Parameter	Unit
pH ($CaCl_2$)	pH units
Cation Exchange Capacity	$cmol_c$/kg
Clay Content	%
Organic Carbon Content	%
Total Iron	%
Total Cadmium	mg/kg (DMB)
Total Copper	mg/kg (DMB)
Total Zinc	mg/kg (DMB)
As required	
Total Arsenic	mg/kg (DMB)
Total Lead	mg/kg (DMB)
Total Mercury	mg/kg (DMB)
Total Nickel	mg/kg (DMB)

Flowchart: Classification Sampling Overview



Appendix C: Biosolids Adjusted Contaminant Concentration

Different BACC calculations are used depending on the sampling method chosen for the biosolids (see Appendix B).

Continuous Sampling of Biosolids

Under a continuous sampling regime, the BACC is derived from samples collected over time. Because the biosolids are typically removed prior to receipt of latest sample results, it is important that the classification procedure takes into account the potential for variation in biosolids quality. For this reason, the contaminant concentrations used in the grading process are not the contaminant concentrations measured from a single sample but are derived from a consideration of the current sample in conjunction with variations in historical data.

The Biosolids Adjusted Contaminant Concentration, BACC, is defined as:

$$BACC = m + 2s$$

Where, m = mean concentration of a given contaminant calculated from last 12 samples

s = standard deviation of the mean concentration of a given contaminant calculated from last 12 samples

To ensure the results used for calculations are representative of the biosolids being classified once the initial sampling period yields 12 samples, the 12 most recent sample results must be used for ongoing BACC calculations dropping older results.

Batch Sampling of Biosolids

Under a batch sampling regime, the BACC is determined using the samples collected for that complete batch and historical data is not used. The biosolids cannot be removed from the production site until classification has been completed (otherwise it must be handled as a sewage sludge and taken to a site authorised to accept sewage sludge). As the sample results are specifically for that batch of material a slightly less conservative BACC calculation can be used.

In these circumstances the Biosolids Adjusted Contaminant Concentration, BACC, is defined as:

$$BACC = m + s$$

Where, m = mean concentration of a given contaminant calculated from all samples

s = standard deviation of the mean concentration of a given contaminant calculated from all samples

Note, while statistically the preference is for at least seven sample results to be used for calculations, it is recognised that some lagoon WWTPs produce very small quantities of sludge, so the requirement is for a minimum of 3 results to be used in this calculation. If the variation in results is considerable (e.g. ± 30%) additional samples may be required.

Contaminant Grading

Once the BACC for each contaminant has been calculated it can be allocated an individual grade in accordance with Table 7.1 (replicated below).

Table 7.1: Contaminant Acceptance Concentration Thresholds for Biosolids

CONTAMINANT	GRADE A (mg/kg DMB)	GRADE B (mg/kg DMB)
Arsenic	20	60
Cadmium	1	20
Chromium (total)	50	300
Copper	100	2,500
Lead	150	420
Mercury	1	15
Nickel	60	270
Zinc	200	2,500

The overall Contaminant Grade of the biosolid can then be determined.

The contaminant grade for a biosolids product is determined by the poorest grade for any one contaminant. For example, if most of the contaminant concentrations in a biosolids product pass Contaminant Grade A, but one contaminant is Grade B, then the entire product is classified as Contaminant Grade B.

Appendix D: Application Rates

Nitrogen Limiting Application Rate

Nitrogen in biosolids is available in two forms, organic and inorganic nitrogen. Inorganic nitrogen (ammonia, nitrate and nitrite) is available for plant use immediately after application. Organic nitrogen is not all readily available.

The fraction of the organic nitrogen content available will depend on the nitrogen mineralisation rate (MR) in the year following application. The MR is assumed to be dependent of the biosolids treatment process (see Table D1 below).

Table D1: Estimated Nitrogen Mineralisation Rate

Biosolids Type	Nitrogen Mineralisation Rate (MR) (first yr of application) (%)
Aerobically digested	25
Anaerobically digested	20
Composted	10

The available biosolids nitrogen (ABN) is calculated using the following formula:

$$\text{ABN (kg/t)} = \frac{\text{(ammonium N (mg/kg) + oxidised N (mg/kg) + (organic N (mg/kg) x MR (\%)/100))}}{1{,}000}$$

Where:

Organic N = TKN – ammonium N

Oxidised N = N as nitrate and nitrite

TKN = Total Kjeldahl Nitrogen

MR = Mineralisation Rate

Once the ABN has been determined the Nitrogen Limiting Application Rate (NLAR) can be calculated using the following formula (being mindful that the ABN will require modification to take into account moisture content of the biosolids):

NLAR (t/ha) = CNR (kg/ha) / ABN (kg/t)

Where:

CNR = crop nutrient requirement (kg/ha) (seek agronomic advice on this – this should take into account results of soils analysis for residual nitrogen as well as typical cropping requirements if a site is to receive frequent biosolids applications in excess of 1 per 3 years)

Contaminant Limiting Application Rate

The method described here for determining the Contaminant Limiting Application Rate is based on the work completed by Warne et al (2008) under the Australian National Biosolids Research Program undertaken to assess in an Australian context the impacts on food quality, crop production and soil health of metal contaminants from the land application of biosolids. Information is also sourced from the South Australian draft Biosolids Guideline for the Safe Handling and Reuse of Biosolids 2009.

Bio-accumulating metals cadmium and mercury were assessed. Maximum soil concentrations for cadmium, determined by soil pH and clay content were derived. This was determined on the basis of risk to human health through food. Cadmium is much more hazardous than mercury therefore by assessing risk of cadmium, the risk from mercury is somewhat addressed. As a contingency factor a maximum allowable soil contaminant concentration for mercury is included in Table D6.

This work also looked at metal contaminants which do not bio-accumulate by first completing a risk assessment to determine which would pose the highest ecological risk. Copper and zinc were found to be the highest risk. A set of soil specific maximum limits for copper and zinc, determined by soil properties for pH, clay content, organic carbon content and cation exchange capacity were then determined.

For other metals found in concentrations in Tasmanian soils, including arsenic, lead, mercury and nickel maximum soil contaminant concentrations have been determined.

The lowest individual Contaminant Limiting Application Rate is the overall Contaminant Limiting Application Rate (CLAR).

Cadmium

As mentioned, the key risk from cadmium is food safety through plant uptake. Some plants, such as leafy vegetables and root crops can have a higher uptake. As a consequence, the National Guidelines advise a maximum application rate should be set.

Maximum Permissible Cadmium Application Rate (MPCAR) = 0.03kg/ha/yr or 0.15kg/ha per 5 yrs.

The CLAR for cadmium can be calculated using this formula:

CLAR (t/ha) = MPCAR (kg/ha/yr) x 1000 / BACC (mg/kg)

However, the maximum application rate may be further restricted depending on soil properties and a second calculation should be completed in order to determine the correct CLAR for cadmium. The lower value obtained is the CLAR to be used. The second calculation is the same as that used for the other metal contaminants and can be found towards the end of this chapter. It requires biosolids contaminant data (BACC), soils analysis results and reference to Table D2 below to select an appropriate Maximum allowable soils contaminant concentrations (MASCC). The soil pH and organic carbon content values in Table D2 are the values of the site being considered for biosolids application.

Table D2: Maximum allowable soils contaminant concentrations of total cadmium

pH	Maximum total cadmium soils concentrations (mg Cd/kg soil)		
	Clay content (%)		
	5	25	50
4.5	0.54	1.17	1.96
5.5	0.68	1.31	2.10
6.5	0.82	1.45	2.24
7.5	0.96	1.59	2.38
8.5	1.10	1.73	2.52

Copper and Zinc

The risks associated with land application of biosolids from copper and zinc are environmental, potentially affecting microbial processes and plant productivity. To address these, the National Biosolids Research Program determined sets of maximum soils concentrations for copper and zinc. Please refer to Tables D3 and D4 respectively. These values are then added to the appropriate value selected from Table D4 which makes an additional allowance on the basis of soil iron content.

The soil pH and organic carbon content values in Table D3 are the values of the site being considered for biosolid application before the application occurs. The concentrations for copper are the maximum permitted concentrations following application before soil iron is considered. When the appropriate value is selected on the basis of these properties and added to the number derived from Table D5 the MASCC for copper is derived.

Table D3: Maximum permitted added biosolids copper concentrations in soils receiving biosolids

pH	mg added biosolids Cu/kg soil Organic Carbon Content (%)						
	0.5	1	2	3	4	5	6
4.0	4	9	18	27	37	46	56
4.5	6	12	25	39	52	66	80
5.0	8	17	36	55	75	95	115
5.5	12	25	51	79	107	135	163
6.0	17	35	73	112	152	193	233
6.5	24	50	105	160	217	275	333
7.0	35	72	150	229	310	392	475
7.5	50	103	213	327	442	560	678
8.0	71	147	304	466	631	799	968

Soil pH and cation exchange capacity were found to be the soil characteristics affecting zinc toxicity and microbial function. The soil pH and cation exchange capacity values used in Table D4 are the values of the site being considered for biosolids application before the application occurs and the concentrations of zinc are the maximum permitted concentrations following application before soil iron is considered. When the appropriate value is selected on the basis of these properties and added to the number derived from Table D5 the MASCC for zinc is derived.

Table D4: Maximum permitted added zinc concentrations in soils receiving biosolids

pH	mg added biosolids Zn/kg soil Cation Exchange Capacity ($cmol_c$/kg)						
	0.5	1	2	3	4	5	6
4.0	15	21	34	56	75	91	121
4.5	20	29	47	77	102	125	166
5.0	28	40	64	105	139	170	226
5.5	38	54	88	143	190	232	309
6.0	52	74	120	195	260	317	422
6.5	70	101	164	227	354	434	576
7.0	96	138	224	364	484	592	787
7.5	131	188	306	498	661	809	1,076
8.0	179	257	418	680	903	1,106	1,470

Table D5: Expected background concentrations of copper and zinc in soils at different levels of soil iron

Soil Fe (%)	Cu (mg/kg)	Zn (mg/kg)
0.1	<4	<4
0.5	<10	<25
1	<15	<35
5	<45	<85
10	<70	<130
15	<90	<165
20	<105	<195
25	<120	<225

<u>Example of calculating MASCC for copper and zinc</u>

If a selected site intended for biosolids application has a pH 7.5, an organic carbon content of 1%, an iron content of 0.5% and a cation exchange capacity of 2 $cmol_c$/kg, the MASCC for copper and zinc would be:

Copper = 103mg/kg Cu (Table D2) + 10mg/kg Cu (Table D5) = 113mg/kg Cu

Zinc = 306mg/kg Zn (Table D3) + 25mg/kg Zn (Table D5) = 331mg/kg Zn

Once these figures have been derived establishing the MASCC for copper and zinc, the CLAR can be calculated using the main CLAR calculation (see below).

Other Metals

While cadmium, copper and zinc have been assessed as the contaminants most likely to pose a risk the CLAR is also determined for the metals in Table D6, if biosolids contaminants testing has determined these metals are present in biosolids at a level warranting ongoing analysis and classification (see Section 7). Note, Chromium is not included in Table D6. This is due to difficulties in determining an appropriate MASCC for chromium due to the variability in concentrations of naturally occurring soil chromium. Instead the contaminant acceptance concentration thresholds (Table 7.1) for chromium is conservative to ensure biosolid chromium will not adversely affect the end use or cause undesirable accumulation of soil chromium through application of biosolids.

Table D6: Maximum allowable soil contaminant concentrations

Contaminant	Soil concentration (mg/kg dry weight)
Arsenic	20
Lead	200
Mercury	1
Nickel	60

Once the MASCC has been determined for all of these metals (cadmium, copper, zinc and Table D6) the CLAR can be calculated using this formula:

$$CLAR = \frac{(MASCC - ASCC)}{BACC} \times SM$$

Where:

CLAR = Contaminant Limited Application Rate (dry tonnes /hec)

MASCC = Maximum Allowable Soil Contaminant Concentration (mg/kg) (relevant calculations for cadmium, copper and zinc and Table D6 above)

ASCC = Actual Soil Contaminant Concentration (mg/kg) (average value from soils samples)

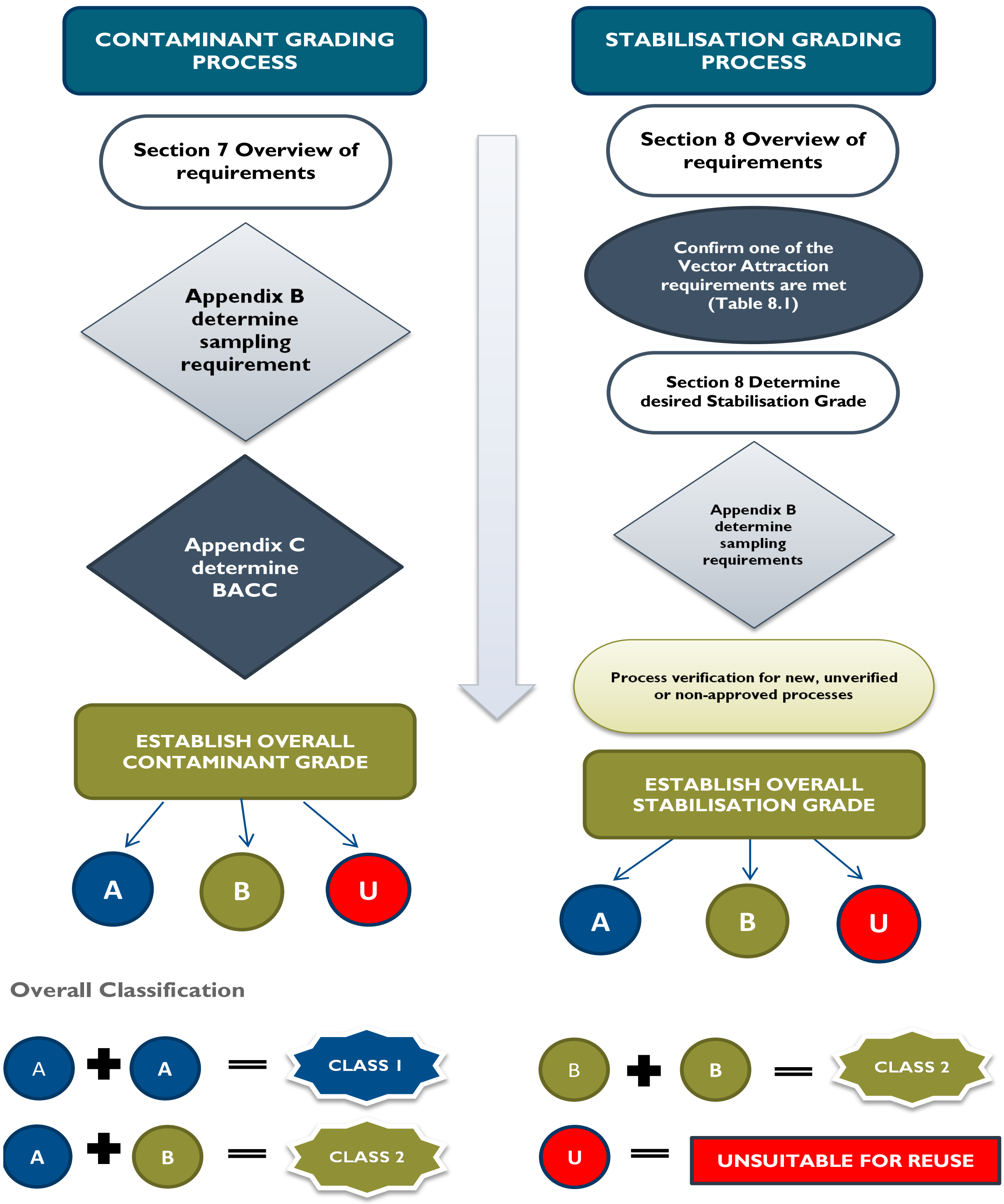
BACC = Biosolids Adjusted Contaminant Concentration (mg/kg)

SM = Incorporated Soil Mass per hectare (dry tonnes/hec) (soil bulk density x incorporation depth x 10,000m^2/ha)

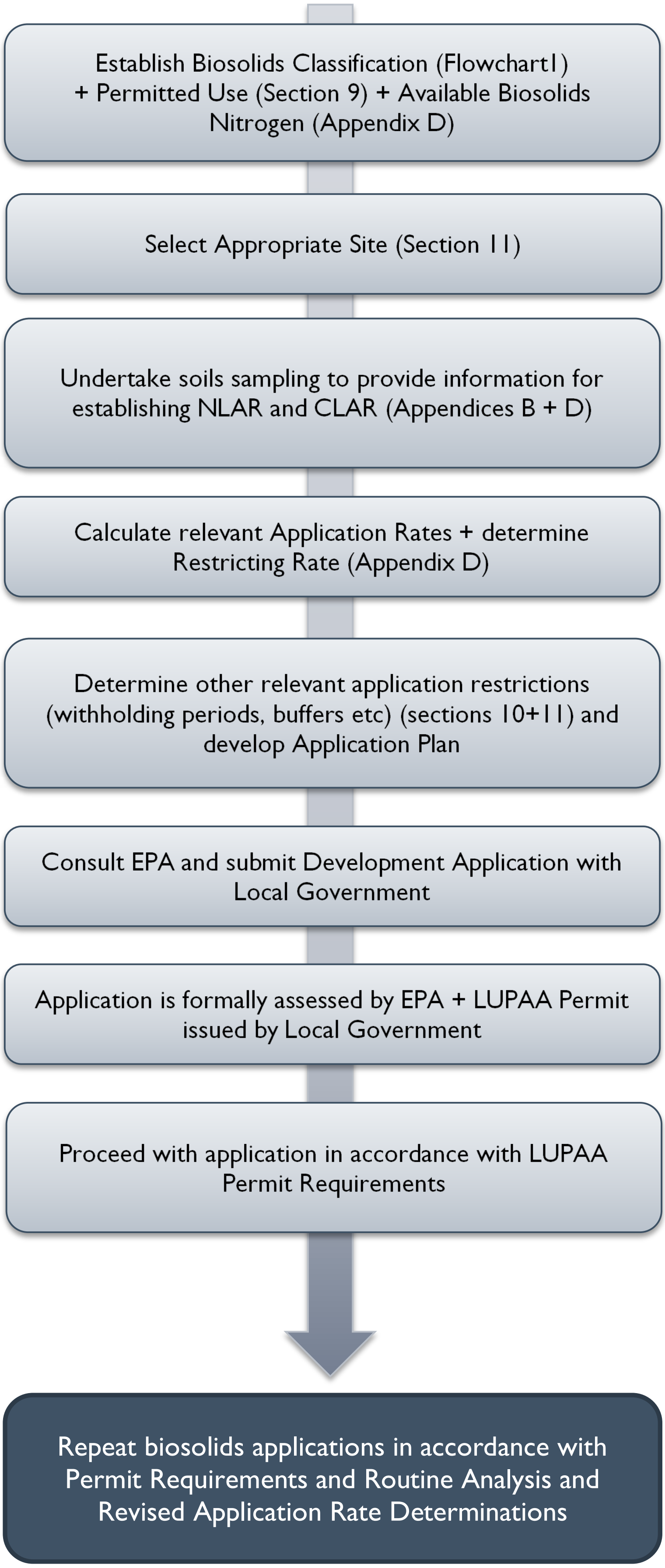
The lowest calculated value (bearing in mind there are two values to be calculated for cadmium) is the overall CLAR for the application.

Appendix E: Approvals Process Flowcharts

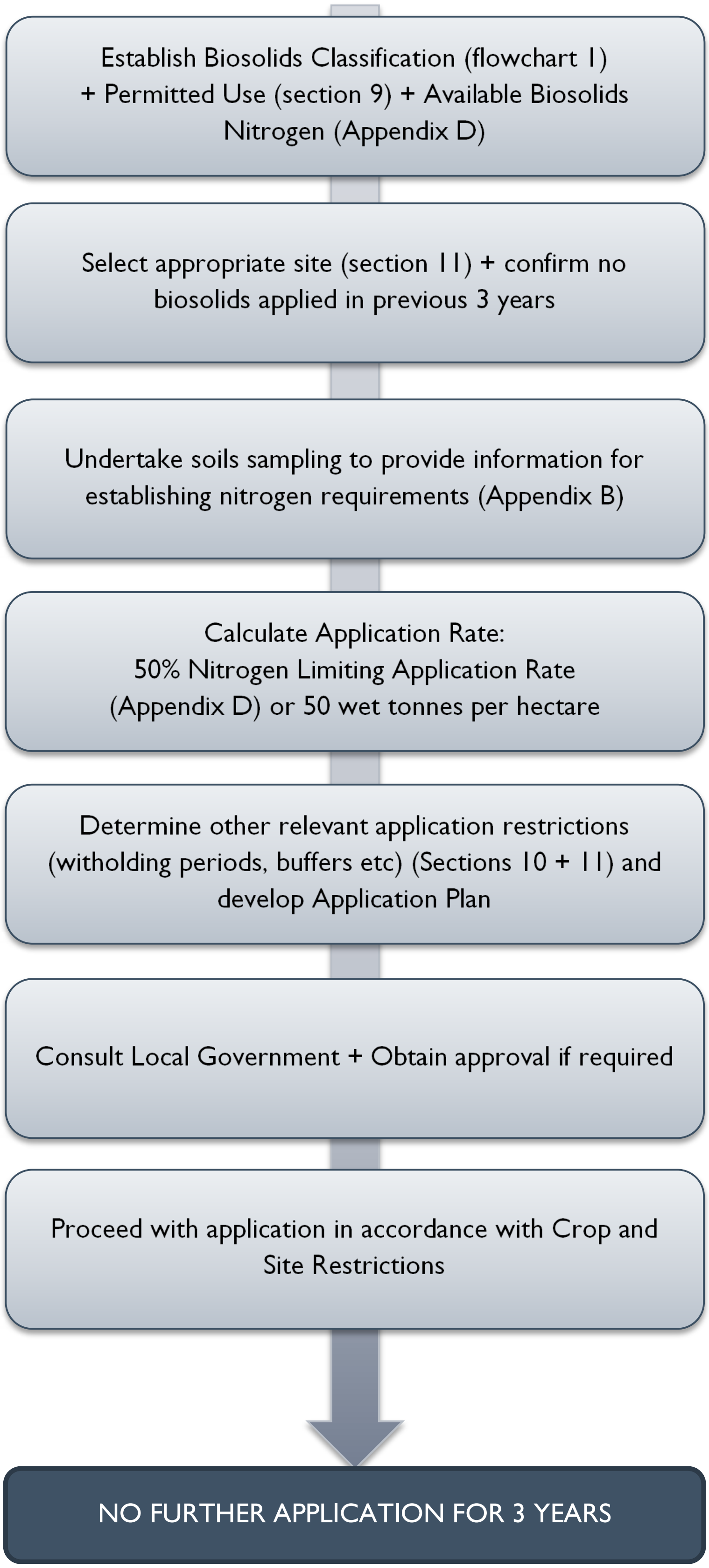
Approvals Flow Chart 1: Biosolids Classification Process



Approvals Flow Chart 2: Level 2 Application Process in Accordance with EMPCA



Approvals Flow Chart 3: Low Rate Application Process in Accordance with the AMM



Appendix F: Worked Example

Tasman Wastewater Treatment Plant (WWTP) is a large urban facility receiving largely domestic and commercial wastewater.

It receives approximately 6 ML/day effluent, producing 700 dry solid tonnes of sewage sludge a year which is anaerobically digested and dewatered using a centrifuge. Biosolids are beneficially reused on agricultural grazing land. The Producer therefore needs to ensure as a minimum Class 2 Biosolids criteria are fulfilled and determine the appropriate Maximum Allowable Biosolids Application Rate.

STAGE 1: Biosolid Classification

For ease in meeting minimum sample requirements, the Producer collects a weekly grab sample composites these monthly and sends off for analysis resulting in 12 annual samples.

Table F1: Tasman WWTP Biosolids Analysis Results and Calculations

Parameter	Units	Sample												Calculation
		1	2	3	4	5	6	7	8	9	10	11	12	
Contaminants														BACC (m + 2s)
Arsenic	mg/kg DMB	3	2	2	3	3	3	3	3	3	3	3	4	4
Cadmium	mg/kg DMB	1	1	1	1	1	1	1	1	1	1	1	1	1
Chromium (total)	mg/kg DMB	10	8	8	11	11	11	13	9	9	10	15	10	14
Copper	mg/kg DMB	197	149	173	176	159	192	207	161	156	152	200	172	215
Lead	mg/kg DMB	16	11	13	15	16	17	19	17	13	15	21	15	21
Mercury	mg/kg DMB	1.25	0.44	0.62	0.55	0.6	0.48	1.82	0.33	0.63	0.67	0.44	1.19	2
Nickel	mg/kg DMB	8	6	6	7	8	8	8	8	7	7	11	8	10
Zinc	mg/kg DMB	462	417	427	460	467	556	571	502	396	415	555	447	593
Pathogens														Mean
E. coli	cfu/g DMB	78,547	135,492	36,127	68,475	174,298	52,368	87,587	87,982	23,475	90,873	141,587	111,821	79,375

Table F2: Classification of Tasman WWTP Biosolids

CONTAMINANT	GRADE A (mg/kg dry weight)	GRADE B (mg/kg dry weight)	Tasman WWTP BACC
Arsenic	20	60	4
Cadmium	1	20	1
Chromium (total)	50	300	14
Copper	100	2,500	215
Lead	150	420	21
Mercury	1	15	2
Nickel	60	270	10
Zinc	200	2,500	593
Biosolids are Contaminant Grade B due to results for copper, mercury and zinc			
STABILISATION			
GRADE B (<200,000,000 cfu/g *E. coli*)	79,375 (meets Grade B)		

The Producer has previously satisfactorily completed a period of process verification for the stabilisation process at Tasman WWTP and the biosolids found to meet odour, vector attraction and stabilisation grade B requirements. The producer also undertakes routine analysis to ensure volatile solids reduction of >38% is maintained and records of process parameters such as temperature and pH are maintained. Routine monitoring confirms Stabilisation Grade B.

Tasman WWTP Biosolids therefore meet Contaminant Grade B and Stabilisation Grade B and Class 2 Biosolids overall and are suitable for the proposed end use. The next stage is to establish the Maximum Allowable Biosolids Application Rate (MABAR).

STAGE 2: MABAR Determination

Biosolids were analysed for nutrient content (Table F3) and composite soil samples were collected from 2 paddocks at the reuse site (Table F4).

Table F3: Biosolids nutrients analysis results

Parameter	Units	Sample												Calculation
		1	2	3	4	5	6	7	8	9	10	11	12	
Nutrients														Average
Ammonia	mg/kg DMB	1,000	900	980	980	1,200	1,100	1,300	900	790	1,600	1,600	1,400	1,150
Nitrate + Nitrite	mg/kg DMB	3.80	1.00	3.10	1.80	3.70	5.70	3.70	1.00	1.00	1.00	2.70	5.00	3.00
Nitrogen, Total Kjeldahl	mg/kg DMB	43,000	36,000	41,000	40,000	39,000	45,000	47,000	38,000	30,000	43,000	43,000	40,000	40,000
Moisture	%	80.5	77.1	79.4	77.5	77.6	80.0	79.1	77.1	75.0	80.8	79.7	78.8	79.0

Table F4: Soils analysis results

Parameter	Units	Paddock A	Paddock B
pH	pH units	5.0	5.0
Electrical conductivity	dS/m	0.08	0.08
Cation Exchange Capacity	cmolc/kg	3	2
Clay content	%	25	25
Organic Carbon Content	%	3	4
Total Kjeldahl Nitrogen	mg/kg	4,100	4,000
Nitrate and nitrite	mg/kg	9	5.3
Ammonia	mg/kg	8.2	17
Iron	mg/kg	88,000	42,000
Arsenic	mg/kg	1	1
Cadmium	mg/kg	0.66	0.68

Copper	mg/kg	10	12
Lead	mg/kg	11	9
Mercury	mg/kg	<0.1	<0.1
Nickel	mg/kg	30	17
Zinc	mg/kg	19	15

NLAR

Step 1: establish the available biosolids nitrogen (ABN):

$$\text{ABN (kg/t)} = \frac{\text{ammonium N (mg/kg)} + \text{oxidised N (mg/kg)} + (\text{organic N (mg/kg)} \times \text{MR (\%)}/100)}{1{,}000}$$

Where:
Organic N = TKN – ammonium N
Oxidised N = N as nitrate and nitrite
TKN = Total Kjeldahl Nitrogen
MR = Mineralisation Rate (20% for anaerobic digestion)

$$\text{ABN} = \frac{1{,}150 + 3 + ((40{,}000 - 1{,}150) \times 20/100)}{1{,}000} = 9 \text{ kg/t DMB}$$

Average moisture content 79% (21% solid) so ABN = 1.9 kg/t wet biosolid. Assuming biosolids will be applied shortly after arrival at reuse area 1.9 kg/t is the appropriate value to use.

Step 2: establish Crop Nutrient Requirement (CNR). An agronomist can advise of relevant crop requirements. In this example were are adopting a crop requirement of 75 kg/ha N for pasture.

(If this is a repeat application on the same sites the CNR is this value with soil available nitrogen deducted. For the purpose of these guidelines it is sufficient to simply sum soil ammonia and oxidised nitrogen. CNR: Paddock A = 75-17 = 58kg/ha, Paddock B = 75-22 = 53kg/ha DMB)

Step 3: determine NLAR.

NLAR (t/ha) = CNR (kg/ha)/ABN (kg/t) = 75/1.9 = 39 wet t/ha

CLAR

The CLAR needs to be established for each contaminant of concern. The following equation is used:

$$CLAR = \frac{(MASCC - ASCC)}{BACC} \times SM$$

Where:

CLAR = Contaminant Limited Application Rate (dry tonnes /ha)

MASCC = Maximum Allowable Soil Contaminant Concentration (mg/kg)

ASCC = Actual Soil Contaminant Concentration (mg/kg) (average value from soils samples)

BACC = Biosolids Adjusted Contaminant Concentration

SM = Incorporated Soil Mass per hectare (for this example a SM of 133.3 t/ha will be used)

Cadmium: two CLARs need to be calculated to adequately address the risks associated with cadmium. The more conservative value is the ultimate CLAR for Cadmium.

The first uses the Maximum Permissible Cadmium Application Rate (MPCAR) of 0.03kg/ha/yr or 0.15kg/ha per 5 yrs:

CLAR (t/ha) = MPCAR x 1,000/BACC = 0.03 x 1,000/1 = 30 t/ha DMB = 30 x 4.8 = 144 wet t/ha.
The second uses the main formula above and is calculated on the basis of existing soil characteristics. Please refer to the soil monitoring results and Appendix D table D1.

Paddock A: CLAR (t/ha) = (MASCC-ASCC) x SM/ BACC = (1.17-0.66)/1 x133.3 = 68 t/ha DMB = 68 x 4.8 = 326 wet t/ha.
Paddock B: CLAR (t/ha) = (MASCC-ASCC) x SM/ BACC = (1.17-0.68)/1 x 133.3 = 65t/ha DMB = 314 wet t/ha.

Copper: Please refer to the soil monitoring results and Appendix D tables D2 and D4 for values to establish MASCC for Copper

Paddock A: MASCC = 55 + 70 = 125 mg/kg, CLAR (t/ha) = (MASCC-ASCC) x SM/ BACC = 71.14 t/ha DMB = 71.14 x 4.8 = 341 wet t/ha

Paddock B: MASCC = 74+45 = 119 mg/kg, CLAR (t/ha) = (MASCC-ASCC) x SM/ BACC = 66.2 t/ha DMB = 66.2x 4.8 = 318 wet t/ha

Zinc: Please refer to the soil monitoring results and Appendix D tables D3 and D4 for values to establish MASCC for Zinc

Paddock A: MASCC = 105 + 130 = 235 mg/kg, CLAR (t/ha) = (MASCC-ASCC) x SM/ BACC = 48.45 t/ha DMB = 48.45 x 4.8 = 233 wet t/ha

Paddock B: MASCC = 64 + 85 = 149 mg/kg, CLAR (t/ha) = (MASCC-ASCC) x SM/ BACC = 30.05 t/ha DMB = 30.05 x 4.8 = 144 wet t/ha

The same process is used for the remaining contaminants. The results for the remaining contaminants are summarised in Table F5 below:

Table F5: Summarised Application Rate Results

Application Rate (t/ha)	Paddock A	Paddock B
NLAR	39	39
CLAR Cadmium 1	144	144
CLAR Cadmium 2	326	314
CLAR Copper	341	318
CLAR Zinc	233	144
CLAR Arsenic	3,080	3,080
CLAR Lead	5,736	5,797
CLAR Mercury	353	353
CLAR Nickel	1,869	2,678
MABAR	39	39

As can be observed the Nitrogen Limiting Application Rate is that which limits the quantity of biosolid which can be applied in both paddocks epa TASMANIA

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