Development of decision support tools for on-farm mass herd euthanasia, disposal and decontamination (DDD) for the Australian Pig Industry in the event of an exotic disease outbreak- Literature Review

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Executive Summary

Background

Preparation is the key to the early and rapid response in relation to a mass mortality event or an identified emergency animal disease (EAD) outbreak. Response activities must be effectively coordinated ensuring the needs of all impacted parties are met. Pre-planning of response activities is essential in identifying roles, methods and resources and assists in limiting the number of on-the-run decisions made during an EAD event.

The Australian pork industry is aware of the need to provide local knowledge and expertise in mass disposal and disease management and has undertaken several initiatives to facilitate pre-preparedness.

This literature review is the first stage in a larger pre-preparedness initiative and considers the situation on an Australian pig farm when an emergency condition, particularly an EAD, such as African swine fever (ASF), may necessitate the depopulation and disposal of pigs, with subsequent decontamination of the site.

Methodology

The authors investigated depopulation, disposal and decontamination (DDD) options for EAD outbreaks in pigs through extensive stakeholder consultation and a review of the available international and Australian literature. Stakeholder consultation included APL's ASF technical committee and other key agriculture and environment agencies at the state, federal and international levels, as well as individual producers. Legislation and regulations applicable to DDD were also reviewed across the relevant jurisdictions.

Regulatory Framework

Under agreed EAD response plans, State Government authorities would develop a Local Disease Control Centre to coordinate the response to an affected site. This includes the depopulation/disposal and decontamination (DDD) of an infected premise and any dangerous contact premises. Previous exercises into EAD have indicated that access to adequate staff and resources would be quickly depleted in any real time DDD response. Also, whilst any DDD activity within a Restricted Area would probably attract support (personnel, equipment, logistics etc) and funding from authorities, any necessary farm depopulation outside that area, due to issues such as lack of processor availability, collapse in market price, movement restrictions etc, may not attract any such logistical or financial support, necessitating a leaner approach.

Under the various Environment Protection Acts in every State or Territory, emergency authorizations can be given in the event of an emergency such as for the disposal of stock during a disease outbreak. These authorizations provide exemptions from parts of disease control legislation to allow activities on- or off-site to occur which, under normal circumstances, would have been prohibited. Examples of on-site authorizations include approval for on-farm burial, temporary composting areas, and the generation of smoke. Off-site authorizations can be granted for sites or facilities to undertake activities or accept wastes they are not normally licenced to receive. Examples of off-site authorizations include the approval for the establishment of a temporary mass disposal site, acceptance of wastes at a commercial landfill, compost facility or renderer and the opening up of a closed landfill for the purposes of disposal. Waste levy exemptions can also be granted under the environmental Acts or regulations and fees negotiated for other facilities in each State to reduce costs of disposal.

Depopulation

The current operational manual for destruction of farm animals during an EAD in Australia is the AUSVETPLAN version 3.2, 2015. This lists the usage of firearms, captive bolt guns, anaesthetic and sedative overdose, blunt force trauma, or inhalant gas (carbon dioxide), as acceptable methods for euthanasia of farm pigs. This manual suggests that pigs subjected to inhalant gas should be less than 30 kg. However, euthanasia of 100 kg pigs by carbon dioxide inhalant gas, captive bolt gun or electrocution occurs in Australia daily, at various processing facilities.

Government agencies typically plan to use on-farm euthanasia methods which involve the handling of individual animals, namely firearms, captive bolt guns, and blunt force trauma. Other individual methods of euthanasia include electrocution and anaesthetic overdose by injection. Individual methods are slow and require large numbers of resources and personnel, which may be limited in a large or multiple farm EAD situation, especially those outside the EAD response funding frameworks. These tasks are repetitive and likely to lead to operator fatigue, with considerable handling and restraint stress to both pigs and workers. These time and resource constraints have been consistently noted in EAD depopulation exercises.

Mass depopulation methods should be considered preferable over individual methods especially for larger sites. These methods are favoured by industry. Mass depopulation involves euthanasia performed on groups of pigs, without the need for individual animal handling through the use of inhalant gas, dispensing of poison baits, foaming, or dispensing of sedative via the water supply. The benefits of mass depopulation are the ability to keep social groups of pigs together prior to euthanasia, the ability to conduct depopulation procedures in a reasonable time frame, even on a large population, reduced individual animal handling or physical restraint, and the ability to simultaneously contain and humanely kill many animals while providing a means for carcass containment and disposal transport. Of these methods, inhalant gas and foaming require greater initial levels of relevant equipment and skilled personnel. Deprivation of water or ventilation is not considered a suitable method for euthanasia of Australian pigs.

The use of a processing facility for destruction and disposal is an acceptable option in AUSVETPLAN (Enterprise Manual for Pigs, version 3.0, 2011). Given that likely transmission pathways of ASF are the same whether pigs are alive or dead, serious consideration can be given to depopulation and disposal via movement to processing and human/pet consumption. This option has clear benefits in terms of operator safety, reliability, practicality, aesthetics and emotional impacts. Suitable pigs can be gathered at the site, inspected, placed into transport trucks and delivered to purpose-built and private processor facilities, to personnel who are experienced and trained at the task of efficient and humane euthanasia procedures. The throughput from an affected farm site could be handled over several days.

Disposal

State agencies facing the disposal of infected carcasses and related materials tend to favour either on-farm deep burial or off-site transportation to commercial landfill facilities. Landfill is an attractive option because it involves the use of a pre-existing facility, typically designed, and regulated with sophisticated by-product (methane and leachate) management systems. Landfill space in some States (particularly Qld and NSW) may be a limiting factor. Generally, on-farm disposal options are not favoured by industry. Uncertainties remain with respect to capacity for on-farm burial, and we have identified that there are significant environmental and biosecurity risk factors associated with this method. For example, during a projected EAD response, a daily depopulation of 1,000 pigs could generate ca. 60 tonnes of carcass. However, on-site excavators could only be expected to bury 20 to 40 tonnes of carcass per day. Land availability is also likely to be limited on many sites. Additional pit safety controls are needed to minimise the potential transmission of pathogens and excess nutrients to ground or surface waters. On-farm above ground burial could be an option in small outbreaks where deep burial is not possible. Other on-farm options include burning of infected carcasses in a pyre or incinerator. On-site legacy impacts are likely to be less for burning compared to on-site burial.

Other than landfill, composting is the only other disposal method that is potentially suitable for small and large-scale outbreaks. It is a well-established and viable option for disposal of carcasses and other materials either on-site or off-site. On-farm composting is most suitable for manure and small pigs (<10 kg). Larger composting operations could be set-up temporarily off-site, probably on Crown land. With adequate pre-planning it could play a significant role in EAD response. The use of carcass grinding equipment would enhance composting times and pathogen reduction.

Commercial rendering of infective pig materials is an effective option for disposal and decontamination. However, operators of rendering facilities are often reluctant to accept infected materials from mass disposal events, due to limited capacity and risk to markets for rendered products derived from an EAD.

Decontamination

Decontamination involves the cleaning of an EAD affected pig farm or processor buildings, equipment, vehicles, and site features, to a point where they do not pose a verifiable risk to disease transmission and to allow the site to return to its functional operation. Pig farms and processor sites are subject to routine disinfection procedures daily, and targeted depopulation/decontamination procedures are performed on an irregular basis on Australian pig farms for control of endemic diseases, such as brachyspira or mycoplasma infection. Site managers and workers are therefore already familiar with the principles of decontamination that would be applied in an ASF outbreak. The successful decontamination of farm sites affected by incursions of ASF has been regularly performed in Europe in the past decade, using the decontamination working steps described below. The types of pigs, farm buildings and ancillary structures on European farms are remarkably similar to those on Australian farms. Epidemiological considerations, such as vehicle movements and local feral pig populations are also similar.

The working steps for decontamination of buildings consist of:

- Dry cleaning: removal of organic debris, loose materials, dis-assembly and/or removal of loose items.
- Wet cleansing: thorough washing and removal of organic material with detergent and warm water. Drying period.
- Disinfection: complete surface application of liquid disinfectant capable of killing microbiological agents. Fumigation of clean structures and equipment with a suitable fogging disinfectant is then applied.
- Finishing off period: re-open and dry the structure and equipment. A separate application of dry surface disinfectant (e.g. hydrated lime) may be applied. Mechanical structures and collections of organic materials are difficult to decontaminate fully. A fallow period is then applied, e.g. 45 to 60 days for ASF.

The chosen disinfectant product should be efficacious, under consideration of its necessary contact time, persistence and kill rate at a likely operating temperature. Oxidising and alkalising agents are considered the preference for ASF decontamination due to appropriate contact time and kill rates at a standard application rate.

Oxidising or alkali disinfectants are considered preferable for targeted ASF disinfection procedures on farm buildings and vehicles. Acid or chloride-based disinfectants are short acting and less effective in areas with organic materials.

No EAD event requiring large-scale DDD procedures under AUSVETPLAN planning has yet occurred in Australian pigs. Targeted decontamination procedures have been performed on the occasional pig farms and processor sites previously affected with anthrax.

Implications

There are significant differences in the projected handling of an EAD DDD event between various State authorities, both amongst themselves and in relation to pig industry preferences. State authorities usually promulgated destruction by individual animal methods, followed by on-site burial; a scenario perhaps suited to a single isolated EAD incident on a smaller farm. Pig industry representatives considering modern larger farm sites favoured off-site DDD methods, or on-site destruction by group methods, followed by off-site disposal.

There are many improvements that could be made to enhance engagement between the pork industry and government decision makers extending to a lack of pig-industry specific expertise in the biosecurity and environment agencies, with virtually no experience in Australia of handling an EAD event affecting pigs.

Ineffective engagement is seen most clearly in the disconnect between the plans of government and what the industry believes is reasonable or practical. A major means of preparation is for piggeries to develop and seek approval for their own EAD response plans, but this will be difficult to achieve due to these inconsistencies. The impact of an EAD outbreak could be unnecessarily aggravated by government and industry not reaching agreement on key issues.

The preference of on-farm burial over other methods is reflective in the guidance material available in each State on burial requirements. The lack of guidance on other methods such as composting and burning has led to a lack of confidence in the consideration of these options as viable for a mass disposal or EAD event. Further research and guidance materials will assist in providing a nationally consistent approach to mass disposal.

Lack of operational guidelines also means that government agencies are inclined to take the 'safe option' with respect to DDD response activities. 'Safe options' for government usually resolve around methods they are comfortable or familiar with. However, these methods do not necessarily align well with the reality of modern Australian pig farming. Few operational-level guidance materials or SOPs exist aside from on-farm burial and most of the guidance material is internal, targeted at decision makers or for non EAD events. The lack of guidance materials targeted at producers limits their ability to prepare for an event. Although DDD response activities need to be assessed on a case by case basis, the lack of nationally consistent operational-level guidelines means that jurisdictions may be forced to make decisions on the fly with little clear direction.

There is an urgent need to develop operational guidance for those in industry and government that require it, without hindering the capacity of the responding agencies to retain flexibility in response matters. Developing better guidance materials requires an improved understanding across both industry and government about operational matters under different EAD scenarios.

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1. Background to Research

The relative isolation of the Australian pork industry means that, with appropriate preparation, outbreaks of exotic animal diseases (EADs) have the potential to be quickly eradicated. Nevertheless, the costs associated with an EAD outbreak in our farms from loss of production and disruption to markets is of significant concern. With a gross value of production of over $1 billion, an outbreak of exotic disease in the pork industry could cause massive financial distress across the pork supply chain including to many family businesses, as well as the broader Australian economy. A rapid and coordinated response to such outbreaks is therefore critical to maintaining our competitive advantage and to minimising economic losses. Consumers are extremely sensitive to real or perceived threats associated with food safety and disease. An EAD-related 30% reduction in pork consumption is likely, based on the recent response of consumers in some countries with similar dietary patterns (e.g. Philippines) to vividly negative media reports of animals with exotic disease.

Of the EAD, African Swine Fever (ASF) is of the highest priority for the Australian pork industry. ASF has not been detected in Australia, but is present in Indonesia, Papua New Guinea, and East Timor.

The Australian pork industry is undertaking various initiatives to strengthen its preparedness and associated response to an exotic disease incursion such as ASF. These initiatives are targeted both on-farm, across the supply chain and through its involvement in the National Feral Pig Action Plan.

One of the initiatives supported by APL is the development of decision support tools for on-farm mass herd euthanasia, disposal, and decontamination (DDD) for the Australia pig industry in the event of an exotic disease outbreak.

This literature review is the initial stage of this larger project and forms the basis of the development of decision support tools specifically aimed at Australian pork producers to enhance their preparedness and response to a disease outbreak. The review covers the three key aspects of an EAD response including depopulation, disposal, and decontamination.

The information and insights contained within the literature review will provide valuable benefits for the Australian pork industry in relation to the identification of practical methods, collation of known guidance documents, an improved understanding of regulatory requirements and the identification of future opportunities and research to strengthen guidance for the industry and decision makers. This will ultimately enhance the confidence and pre-preparedness in depopulation, disposal and decontamination methods for not only the industry but decision makers who have little experience in real life application of the methods due to the lack of pig mass disposal or EAD events in Australia. There is the potential to collaboratively drive pre-preparedness in a manner that leads to an overall improved EAD response process that is practically feasible, socially acceptable, environmentally responsible, and most importantly based on industry's needs.

2. Objectives of the Research Project

This project sets out to:

1) Provide a comprehensive literature review of depopulation, disposal, and decontamination methods for further consideration.

This literature review forms the initial stage of the larger proposed project "Development of decision support tools for on-farm mass herd euthanasia, disposal and decontamination (DDD) for the Australia Pig Industry in the event of an emergency animal disease outbreak".

3. Methodology

This literature review is the first stage in a larger initiative that aims to assist the Australian pig industry prepare for an emergency animal disease (EAD) outbreak, especially one caused by African swine fever (ASF). This review establishes the groundwork for subsequent stages of the project which will develop tools to assist piggeries in preparing site-specific EAD response plans. The type of information sought via this review included:

- Practical and technical detail on the recommended processes for depopulation and disposal of pigs and related materials and the subsequent decontamination of the site.
- Pros and cons of various methods, including how quickly approval can be gained for return to normal business practice.
- Regulatory requirements with respect to animal welfare, biosecurity and environment between different jurisdictions.
- Identification of data/information requirements for effective decision making.
- Aspects such as community and environmental legacy, future land use, work health and safety, legal, financial, and other considerations.

Technical and scientific aspects were investigated in the international peer-reviewed literature through searches of academic library databases, as well as through a review of the AUSVETPLAN manuals and published research reports. Legislation and regulations applicable to depopulation, disposal and decontamination were also reviewed across the different jurisdictions.

The review also involved substantial stakeholder engagement which included APL's ASF technical committee and other key agriculture and environment representatives at the state, federal and international levels, as well as individual pig producers. This engagement process will continue throughout the project. Organisations contacted so far in the preparation of this review include[1]:

Australia

Agriculture Victoria, Victoria
Animal Disease Intelligence, Victoria
Australian Chicken Growers Council, Victoria
Australian Pork Ltd., Canberra
Barry Lloyd and Associates, South Australia
Biosecurity, Tasmania
Camperdown Compost Company, Victoria
CM Farms Pty Ltd, WA
Department of Primary Industries and Regional Development, WA
Diamond Valley Pork, Victoria
Environment Protection Authority, South Aust
Environment Protection Authority, Victoria
Gippsland Water, Victoria
Little River Pork, Victoria
Pork South Australia
Reilly Pastoral Company, Queensland
Rivalea Australia, NSW
Ross Cutler and Associates
Alltech Lienert Australia, South Australia
AP Food Integrity Pty Ltd
Australian Organics Recycling Association
Australian Renderers Association
Biosecurity, South Australia
Braebrook Pastoral Company, Victoria
Chris Richards and Associates, Victoria
Department of Primary Industries, NSW
Department of Water and Environmental Regulation, WA
Environment Protection Authority, NSW
Environment Protection Authority, Tasmania
Gippsland Pork, Victoria
Linley Valley Pork, WA
McMahons Piggery, South Australia
Department of Environment and Science, Qld
Ridley Corporation
Rob Wilson Consulting
Sacyr Environment Australia Pty Ltd

[1] Only organisation names are included here, but in many cases, multiple people were consulted within a single organisation.

Sunpork Fresh Foods, Queensland
Water Hold Pty Ltd, NSW
Victorian Farmer's Federation

International

American Association of Swine Veterinarians, Iowa, USA
Food and Environmental Hygiene Department, Hong Kong
Philippines Association of Swine Practitioners
Pig Improvement Company, Ukraine
South China Agricultural University, China
Swine Services Ltd., Minnesota, USA
Virginia Department of Environmental Quality, USA
Da Bei Nong Group, China
Ministry of Agriculture, Romania
Pig Improvement Company, Russia
Smithfield Ferme, Romania
South Dakota University, USA
United States Department of Agriculture

4. Introduction

Pork remains the number one most consumed meat globally, representing 35% of global meat consumption, providing a safe, tasty and nutritious source of dietary protein.

There are *ca.* 2,700 separate pig farming operations in Australia, housing ca. 250,000 breeding females producing *ca.* 5 million pigs to market each year. This represents *ca*. 0.5% of global pig meat production.

This review considers the situation on an Australian pig farm when an emergency condition may necessitate the depopulation and disposal of the herd or group of pigs, with subsequent decontamination of the farm site.

4.1 Depopulation and Disposal Emergency Conditions

Urgent circumstances that may require the efficient depopulation of a herd or group of pigs include, but are not limited to:

1. Natural disasters, such as floods, fires, earthquakes: Depopulation may be required when pigs cannot be removed from harm's way and therefore depopulation is necessary to prevent or relieve suffering. Following a natural disaster, pig housing may be severely damaged, losing structural integrity, and/or basic services needed for animal care may be damaged, with farm conditions unable to be safely restored in time to prevent or relieve suffering.

2. Non-natural disasters, such as terrorism, bioterrorism, conventional or nuclear attack, large-scale accident: Depopulation may be required when pig housing is severely damaged, losing structural integrity and to prevent or relieve animal suffering and protect farm personnel health.

3. Intoxications or contamination of food/water supply, such as toxic chemical spill: Depopulation may be required when pigs are exposed to toxic substances, or to contaminants of food or water supply, to prevent real or perceived threats to food safety or to pig health and welfare due to the exposure.

4. Zoonotic or pandemic disease: Depopulation may be required because of real or perceived public health threats, such that pigs can no longer be moved or marketed, e.g. anthrax, influenza.

5. Severe market disruption: Depopulation may be required for any eventuality that reduces or eliminates the marketability of pigs, to a point where no other solutions exist and to prevent animal suffering.

6. Emergency animal disease: Depopulation may be required by State and Commonwealth officials as defence against a reportable and infectious disease, e.g. African swine fever, as reviewed further below.

4.2 Emergency Animal Disease Strategy

The preparation plans and guidelines to respond to an emergency animal disease (EAD) anywhere in Australia are outlined in detail in the AUSVETPLAN documents. In summary, an Emergency Animal Disease Response Plan (EADRP) is generated by the State Chief Veterinary Officer (CVO). The EADRP is then considered by the Consultative Committee on Emergency Animal Diseases (CCEAD), a technical committee, which advises the National Management Group (NMG), which declares the infected premises, see Figure 1.

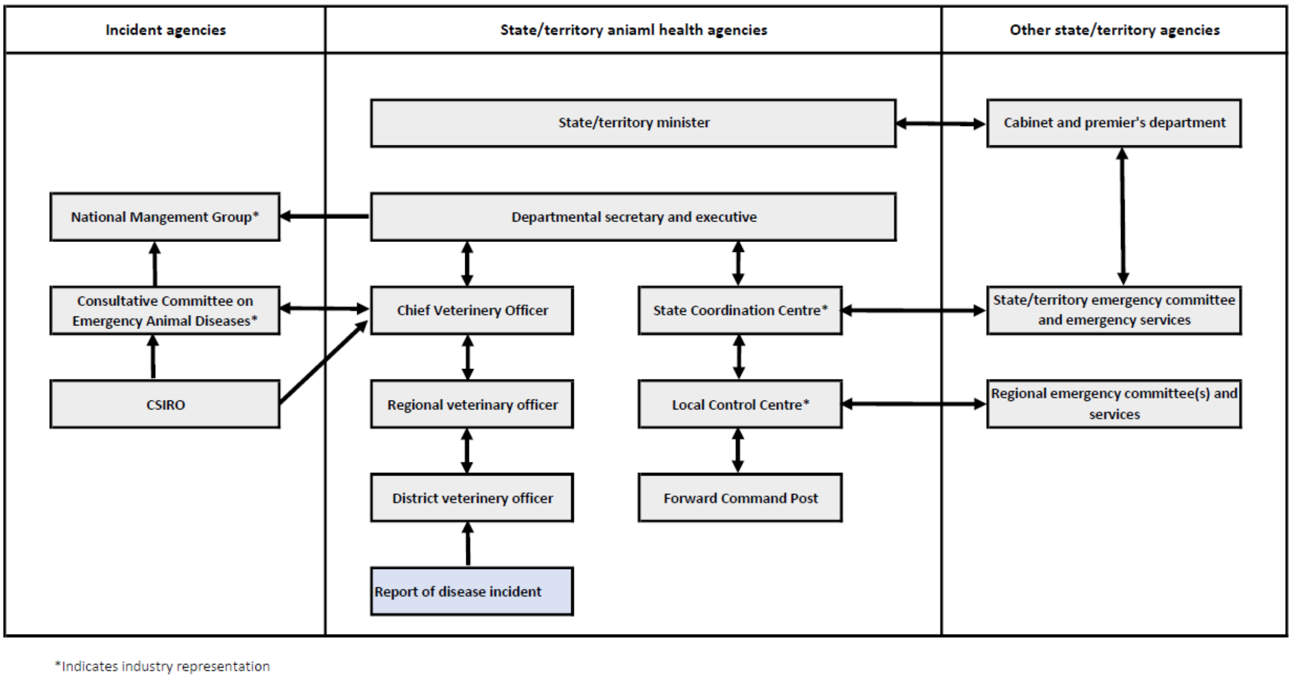

Figure 1. EAD response arrangements, for a localised incident.

A key event is the setting up of the Local Control Centre (LCC), where the response to the affected farm is coordinated by State Government authorities. The successful control and eradication of several potential EAD situations, such as ASF, includes consideration of depopulation of an infected premise (IP) and any dangerous contact premises (DCP). The rationale for depopulation or "stamping out" is to prevent disease spread and animal suffering, leading to rapid control and eradication of disease. This control leads to mitigation of further losses and is combined with active surveillance, tracing and movement restrictions of relevant stock and vehicles. The position of the depopulation, disposal and decontamination teams in a typical LCC response structure is indicated in Figure 2.

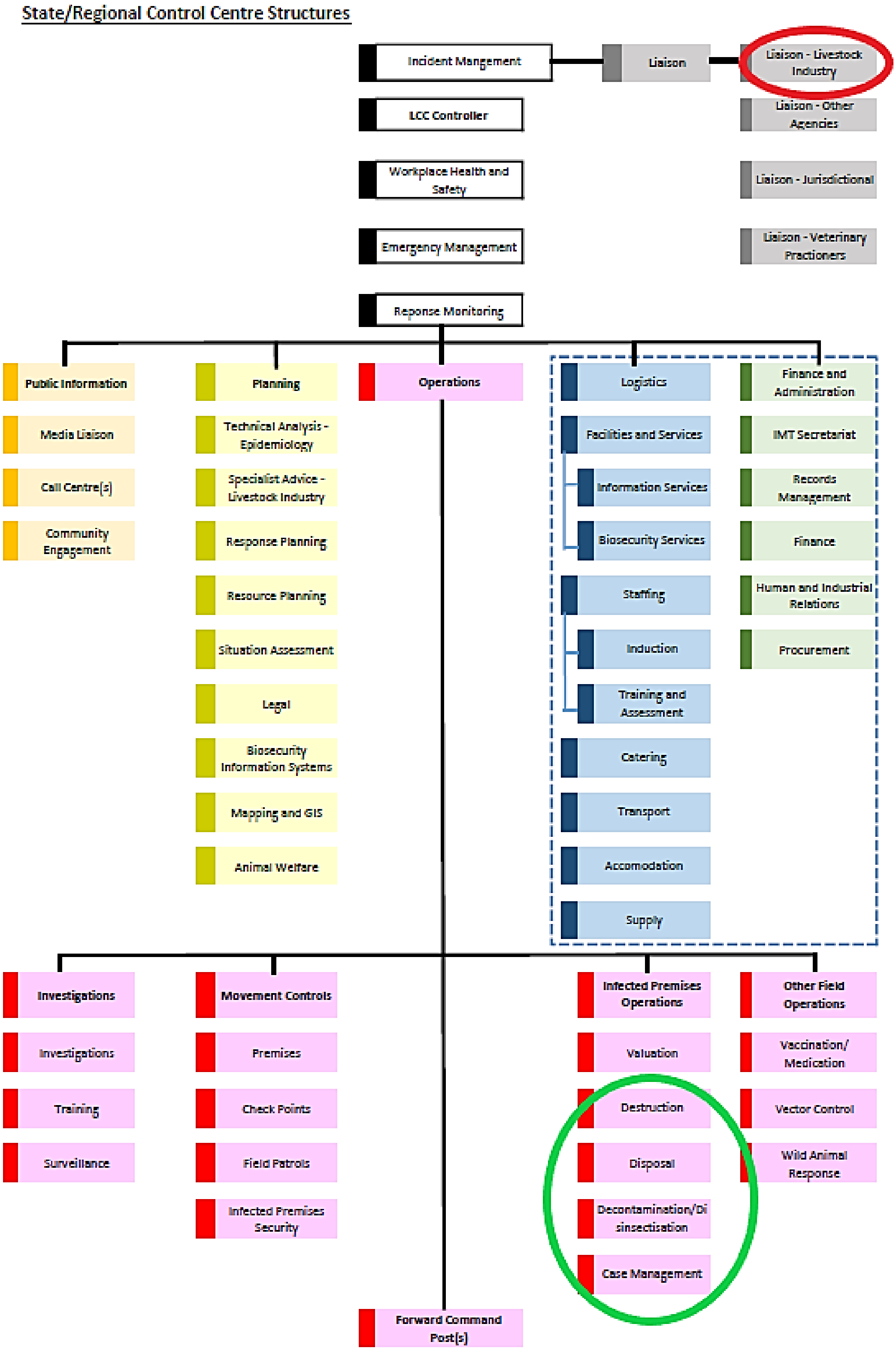

Figure 2. Likely organisation of a Local Control Centre in an EAD.

The suggested responses by individual Australian pig farmers related to this type of EAD outbreak are outlined in the 2019 APL document "Preparing your business to survive an emergency animal disease outbreak: A 30-Minute Plan for Piggeries". This planning tool suggests ways producers can manage the risks of loss of income, movement restrictions, feed shortages, disease control measures etc.

The current Government-led policies for the destruction (depopulation) and disposal of animals, and decontamination of the farm (DDD) are outlined in AUSVETPLAN, for example, AUSVETPLAN Response strategy African swine fever, Version 5.0, 2020, section 4.3. The relevant decision-making personnel in this structure are the Operations manager at the LCC and the on-site supervisor at the IP. Along with the CVO and other advisers, these are the individuals who must make decisions and implement any necessary DDD procedures. Many of the DDD procedures may involve interaction with the local industry liaison officials for key information, such as local processors or disposal sites.
Besides surveillance and tracing, a key feature of successful stamping out procedures is the payment of indemnity to farms or processors for any forced depopulation. The assumption is that Government/Industry compensation via a State-administered line of credit is likely to be available for an affected pig farmer or processor in the event of depopulation of an IP or DCP within a Restricted Area, which would include 100% compensation for: (i) market value of animals that die from the EAD, (ii) market value of animals which are destroyed by official order, (iii) Any pig destruction and carcass disposal and decontamination costs, including the wages and allowances (meals etc) for any staff employed to appraise and conduct the procedures. It is recognised that the owner of some or all pigs located on any site may differ from the owner of the site itself. The previous enforcement of EAD situations in Australia indicates that farmers are not likely to be compensated for any business interruption or consequential losses, on-going wages, capital items, property losses or major equipment purchase. Any depopulation and disposal within a Restricted Area, for EAD control purposes under an approved EAD response plan (EADRA) would attract support (personnel, equipment, logistics etc) and funding from Government and related authorities.

Pigs located in any Control Area around an infected premise, typically established within a 10 km radius, or larger depending on biosecurity risk assessment and physical features (rivers, State borders, etc), are not allowed to move outside of this area until inspected and proved negative. All movements, such as to slaughter following inspection, are under permit certification.

Information concerning the size and proximity and an initial sampling of local feral pig populations is required. Appropriate biosecurity measures, such as pig-proof fences, may be required to reduce local transmission.

This means that there may be considerable differences in the depopulation and disposal procedures conducted on various farms in and around an EAD outbreak. Any depopulation and disposal within a Restricted Area, for EAD control purposes under an approved EAD response plan (EADRA) would attract support (personnel, equipment, logistics etc) and funding from Government and related authorities. Previous exercises into EAD preparedness in Australia have also indicated that access to adequately trained and experienced staff would be quickly depleted and become a critical issue in a real time DDD response. Also, any necessary depopulation and disposal outside the Restricted Area, due to issues such as lack of processor availability, collapse in market price, movement restrictions etc, may not attract any such logistical or financial support, meaning that these DDD procedures may be of a markedly different nature. Such incidents are well-documented in pig EAD situations elsewhere, eg responses to swine flu in Canada.

This review therefore considers procedures likely to be "approved" under an EADRA, as well as other procedures under development. Ongoing consultation and in-principle agreements by the relevant Government authorities and farmer, processor, transport groups and other stakeholders in potential DDD activities are necessary for any pre-determined plans to be effective.

4.3 African Swine Fever Responses

African swine fever is now recognised as the leading business and animal welfare risk for pig farms and related industries globally. There is no effective vaccine or treatment. Control policy for an ASF incursion within Australia currently demands test and slaughter of infected premises towards stamping out.

The highly pathogenic ASF Georgia strain infection of pigs is currently endemic in several parts of Europe and eastern Asia, including Indonesia, Papua New Guinea and East Timor. The likely routes of transmission of ASF into Australia include unintentional or malicious dispersal of infected pork arriving via international ports or infection of feral pigs via infected waste at remote landing sites.

The 3 key features of typical recent ASF situations among infected areas in Europe and Asia consist of:

I. high case fatality: groups of infected pigs typically suffer mortality rates of 90 to 100%. The likelihood of live carrier pigs is therefore limited, but the depopulation of an infected farm is important to limit animal suffering.

II. tenacity: ASF virus is highly persistent in meat and dead carcasses. It can survive freezing and putrefaction events. The proper disposal of carcasses of infected farmed and feral pigs is therefore critical.

III. low contagion: newly infected farms typically only have one sick pen, with slow spread to other pens within the farm. It is therefore possible that separate sections of an IP or other farm may be either positive or negative for ASF infection. Also, aerosol spread of ASF onto neighbouring areas of livestock is not considered a major factor in consideration of DDD procedures, particularly in comparison to FMD.

One eventual aim of depopulation, combined with disposal and decontamination, is to allow recovery and re-use of the farm or processor site as a functional operation. This aim has been regularly achieved in sites affected with ASF in Europe, with re-entry of pigs and negative ASF status achieved after a relatively short period.

5. Environmental Regulations in Australia - Disposal and Decontamination

5.1 Introduction

Environmental considerations are a key factor in determining on-site or off-site disposal options in a mass animal disposal event. Other relevant factors include the proximity to off-site facilities such as landfills, commercial compost operations, rendering plants and purpose built/identified facilities (mass burial sites). Potential disease transmission is also an important consideration in the determination of the suitability of movement of pigs off site. Diseases which are highly transmissible or situations that require the movement of stock using transport routes near other susceptible livestock may facilitate the need for on-site disposal only.

Similarly, any chemicals used to decontaminate an affected site may influence potential contamination of the surrounding land, groundwater, waterways and effluent system and the need for mitigation and clean up strategies.

The general provisions/duties of the respective Environment Protection Acts in each State of Australia include the minimisation and protection of the beneficial uses of the land, groundwater, surface waters, air, and community amenity.

Hence the considerations for on-site disposal and decontamination locations include:

- Soil types (e.g. low permeability soil may minimise leaching to groundwater. Where no suitable soils exist, then lining or additives (e.g. bentonite) can assist in creating an impermeable base).
- Topography – the avoidance of steep slopes or hilly areas to allow machinery access and minimise run-off and erosion.
- Buffers from watercourses, wetlands, and drainage lines to minimise run-off.
- Buffers from remnant vegetation or conservation areas.
- Avoidance of flood prone areas.
- Distance to groundwater – e.g. activity kept at least 2m above the highest seasonal water table.
- Consideration of separation distances to sensitive uses (e.g. neighbouring houses), farm boundaries and local roads.

In contrast, the considerations for off-site disposal and decontamination facilities or locations include:

- Proximity to the affected site(s).
- Transportation routes to assist the avoidance of susceptible livestock.
- Capacity.
- Equipment – e.g. trucks, containers, grinders, spreaders.
- Ability to process infected and non-infected livestock separately (if required).
- Disruption to normal business operations, e.g. downtime to resume processing of non-infected livestock.

The following sections outline and analyse the roles, emergency provisions, disposal preferences, and environmental requirements and guidance for disposal and decontamination for the pig producing States in Australia, including the relevant national AUSVETPLAN manuals, Victoria (Vic), Queensland Qld), New South Wales (NSW), Western Australia (WA), South Australia (SA) and Tasmania (Tas). A summary of these for each State can be found in Table 1.

5.2 Overview

The Environmental Protection Agency (EPA) of each State of Australia is responsible for the management and protection of the environment, water resources and public health through various policies, regulations, and the enforcement of their Environment Protection Acts. The main areas of responsibility are the protection of the land, air, water and groundwater and the control of pollution derived from such areas as waste, noise, and radiation. For the purposes of this review, when referring to an EPA, this shall include the Department of Water and Environmental Regulation of WA (DWER) and the Queensland Department of Environment and Science (QDES).

5.2.1 Roles

For a mass disposal and decontamination event, the State EPA is responsible for the waste management and disposal aspects and protection of the environment to ensure that methods have a minimal environmental impact. EPAs are not the lead agency in a mass disposal event, rather they work alongside State government agencies such as agricultural departments and/or biosecurity agencies. The EPA involvement is triggered at the time of the event to assist in identifying suitable disposal options regarding on and offsite locations and facilities. That is, they will assess the location based on the key environmental considerations and identify a suitable on site disposal location or identify offsite facilities such as landfills, composting operations and renderers and negotiate for those facilities to accept the dead livestock. This will be done in conjunction with the relevant agency's advice re disease transmission and movement.

5.2.2 Emergency Authorizations

Under all the various Environmental Protection Acts, each EPA has the powers to provide emergency approvals for the disposal of dead livestock. This allows for deviation from certain environmental requirements in the case of an emergency or temporary event. It may allow for certain activities to be carried out which under normal circumstances would be prohibited or against licence conditions. These emergency approvals can be granted to the producer for on-site activities or for an off-site facility to undertake an activity or receive a waste, which they may not normally be able to receive. As examples, emergency approval or temporary licence may be granted for:

i. livestock burial to be conducted on-site (this is generally prohibited as a normal management practice),
ii. set up a temporary compost area on-site, and
iii. generation of substantial smoke, even though it may temporarily impact on sensitive receptors (e.g. residential houses).

These approvals can also be granted for off-site activity, such as the development of a temporary landfill, or for facilities such as a commercial landfill, industrial composter, or renderer to accept waste they may not normally be licensed to receive. These approvals can also provide for the opening up of a previously closed landfill, to temporarily receive the dead livestock. This type of emergency approval may be given quickly either verbally or in writing and usually has attached conditions to minimise the environmental impact, as far as practicable.

The EPAs can also grant waste levy exemptions under their various Acts and regulations. This provides the ability to waive the waste levy fee which would have been charged for the disposal of the waste material under normal circumstances. This effectively reduces the cost of disposal to facilities such as landfills, in the event of a mass disposal event. Fees charged by other facilities such as composting operations may also be waived or negotiated in an emergency animal disease situation. This can occur in all States, except Tasmania, which has no current waste levy applied.

5.2.3 Disposal Preferences of the States of Australia – summary

Significant differences were identified between the States of Australia for the "preferred" method of mass disposal of pigs. In two States, there were also differences between their EPA and the other State agencies (Agriculture/Biosecurity). Most States indicated that the disposal method would be determined on a case-by-case basis and encouraged preparedness by individual producers to assist in decision making.

Disposal preferences from the State agencies were influenced by:

i. operational factors: the relative isolation of the piggery site, the capacity and proximity of any off-site licensed facilities, and
ii. potential media coverage and public perception and lack of confidence in the information, guidance and science around successful disposal methods of pigs in Australia (especially regarding composting, leachate potential and disease elimination).

It was mentioned on numerous occasions that the agencies don't have the experience and knowledge in mass disposal of pigs as there have been no major events to put any process into practice whereas they are used to dealing with mass disposal events involving poultry. Thus, there is a lot more guidance material and confidence in the methods employed in an incident involving poultry. The latter two factors lead to a cautious approach in some agencies.

On-site mass burial of dead pigs was the favoured disposal option among the states of Australia. This is despite its associated concerns, regarding potential disease persistence and the possible leaching of contaminants, including live infectious agents, into groundwater systems. The main perceived advantage of burial was the placement of the carcasses out of public gaze (i.e out of sight out of mind mentality).

The removal of pigs to a licensed disposal facility off-site (or unlicensed facility with EPA authorization) was favoured by a several States, albeit with possible limitations of capacity, proximity and business disruption. The disposal of pigs into off-site landfill was favoured over off-site composting or rendering facilities. It should also be noted that the Australian Rendering Association indicated that the majority of renderers lack the capability to handle whole carcasses or receive large volumes of bulky pigs and thus this is unlikely to be a feasible disposal option for the pig industry.

Only two States considered composting on-site a suitable disposal option. Off-site composting was considered a top preference in another two States. The other States viewed composting on or offsite a lower option. The lack of information around successful composting, especially of carcasses containing infectious agents, was noted. A lack of science regarding carcass composting of pigs was a major factor.

The burning of pig carcasses was not considered a preference in some States, due to public perception concerns (the UK FMD outbreak was referenced by most jurisdictions). These concerns were considered by people within the State agencies to over-ride its known disposal advantages, related to its suitability in sites with high groundwater, its ability to eradicate infectious agents, and the usefulness of remnant ash materials.

5.2.4 Guidance documents for disposal in an EAD

Internal guidance documents for each State, outlining the State-controlled operation of an EAD incident, via an operations group looking at DDD amongst other issues, exist – see Figure 2.

The operational manuals AUSVETPLAN Disposal version 3.1. 2015, and AUSVETPLAN Decontamination version 3.2. 2008 outline the current nationally agreed approaches for the disposal requirements within an EAD response in Australia. AUSVETPLAN provide high-level objectives rather than the operational details required to achieve outcomes.

To supplement the overall policy material within AUSVETPLAN, guidance materials consisting of environmental requirements and operating procedures for the various disposal methods have been developed by most States. These, guidance documents have largely focused on mass burial. There is little guidance for pigs on mass disposal for composting and burning or other methods. This lack of guidance and subsequent lack of confidence in such methods is reflective of the jurisdictional preferences of the State agencies.

The guidance documents have been developed by the State agriculture agencies and EPA. In some States both agencies have guidance materials on the same method. Inconsistencies in guidance have been identified within or across State agencies. This lack of consistency could lead to issues during an EAD event.

The guidance material varies in its level of detail and is often focused on non-intensive production systems or routine mortalities rather than an EAD. Although this is the case, many jurisdictions will still use this material in the event of an EAD due to the absence of specific guidance. Many of the guidance documents are targeted for use by decision makers in the event of an EAD and do not specifically address farmer involvement or preparation. Many of these documents are for internal use only and not available publicly. It is unlikely that the industry and more specifically individual producers are aware of these materials (such as Victorian DJPR Incident Action plan) and whether they could be used to assist in pre preparedness planning for an EAD.

To create consistency and avoid reinventing the wheel, many of the States, especially the smaller jurisdictions have based or adopted their guidance materials from the larger State agencies. Many were supportive of a national approach to guidance material for this reason.

5.2.5 Mass Burial Guidance Materials

Every State in Australia has guidance material relating to on-farm burial. Most of this material is aimed at routine stock disposal and often excludes intensive livestock premises or diseased stock. Although this material excludes intensive livestock and diseased stock it is often referenced in EAD disposal guidance outlining environmental requirements. Most of the mass disposal guidance on burial has been prepared for the State government agencies for their internal preparedness policies rather than for producers for preparedness activities. Various guidance documents on burial across the States addressed such topics as on farm burial during an EAD response, identification of mass burial sites (off-site), disposing of carcasses and contaminated materials to licensed landfill, animal carcass disposal and general livestock disposal after a natural event (fire, flood, drought). Some States had multiple documents targeted at various audiences whereas, two States, SA and Tas had no set guidelines on mass disposal via burial for an EAD event. The latter are assessed on a case-by-case basis under the general EPA provisions to prevent the pollution of surface waters, groundwater, the land and too minimise amenity impacts (odour, dust, noise). South Australia has undertaken widespread land profiling to identify suitable sites. Tasmania uses the AUSVETPLAN as a base and may use its bushfire burial guidelines to assist in determining suitable sites. It should be noted that three of the States (Vic, Qld, and WA) had several documents on burial that appeared to vary in regard to the environmental requirements. This occurred across and within agencies. In Victoria's case there appeared to be additional requirements in the DJPR *Guidelines for on-farm burial of animals in an EAD* compared to the EPA guideline *Farm Waste Management.* Queensland also had differences between *Establishing a mass burial facility for disposal of carcasses document and Procedural Guide- Incident Response 2.17 Attachment 9.* Refer to Appendix A for details.

5.2.6 Composting Guidance Materials

Only two States (NSW and SA) have guidance documents with operational procedures for composting. Western Australia had brief detail on composting but no operational requirements. New South Wales has a procedure, publicly available, relating to the disposal of large animals via composting. The NSW EPA document details the relevant preparation, safety and environmental requirements, compost cover, construction resources and equipment required, and post-compost management. The SA EPA requires that emergency composting needs to meet the requirements of a normal licensed composting facility. These objectives are relatively high level and provide guidance on the operation of licensed composting facilities and the suitable distance of composting sites to waterways etc. Note: there are waste processing limits outlined in the SA document that require licencing. In the case of an emergency, an emergency authorization (see above) would likely be given to provide an exemption from these limits and enable the rapid permission of an unlicensed site to perform composting activities. This would be permitted so long as the general objectives of the *EP Act* are met to ensure minimal impact to the environment. Under normal circumstances obtaining a licence would take considerable time to obtain.

None of the other States (Vic, Qld, WA and Tas) have any specific guidance on mass disposal composting for pigs. It is likely that a site would be assessed on a case by case basis and would need to meet the general provision of the various *EP Acts* i.e. not pollute surface waters, groundwaters, air, land etc. This lack of guidance appears to reflect the reluctance of many of the States to consider both on and off-site composting as a viable method for mass disposal for a natural or disease event.

In some States this lack of guidance for composting as a mass disposal method for pigs contrasts with its wide use in the poultry industry. This is perhaps due to the extensive research, guidance material and experience with successful poultry composting as a method of mass disposal. A lack of confidence in pig composting due to the lack of science, guidance and experience with rogue operators was a clear theme in why State agencies had a lower preference for composting despite the environmental benefits and reuse potential over other methods such as burial with its concern of leachate management and disease persistence.

5.2.7 Burning Guidance Materials

No operational guidelines relating to the burning for mass disposal of dead pigs exist currently, beyond what is in AUSVETPLAN (general pyre construction). The use of burning would therefore be assessed on a case-by-case basis under the general EPA provisions to prevent pollution of land, water and (smoke) and provide appropriate buffer distances. Burning was a low preference for most States. This low ranking appears to stem from multiple States referencing the FMD outbreak in the UK which had widespread media coverage of smoke rising from pyres on adjacent farms (Figure 3). This method was seen as a public/social perception issue due to the UK event even though Australian piggeries are generally not located in close vicinity to other piggeries due to biosecurity concerns and are located in rural locations with low populations. The environmental benefits of burning were acknowledged as being superior to other disposal methods regarding minimal risk to groundwater and surface waters and that remaining ash could be incorporated into the soil as a soil conditioner. It is also noted that emergency EPA authorization can be given to allow temporary discharge of significant smoke emissions during any emergency event.

It should be noted Victoria have a *SOP for the incineration of carcasses using an above ground 'Burn Boss' air curtain incinerator 2020* but these are more procedural and relate to the operation of the machine and provide no environmental considerations. *NSW Animal carcass disposal Primefact 2017* mentions burning but refers back to the AUSVETPLAN.

Figure 3. Mass disposal during Foot and Mouth event UK. Source: dailytelegraph.co.uk

5.2.8 Other Disposal Guidance Materials

No operational guidelines relating to the mass disposal of dead pigs exist currently for other potential disposal methods: anaerobic digestion, alkaline hydrolysis and ocean/mine/incinerator disposal.

AUSVETPLAN contains suggestions for disposal of pigs into an anaerobic digester but does not address the environmental requirements or high nitrogen content of pig carcasses and limitations in digestate management and reuse which will be a key factor in utilising such a system for disposal. The high nitrogen content of pig carcasses together with the high biomass will likely make this option challenging.

Other countries such as the US are currently developing *Draft Guidelines for the Emergency Use of Above Ground Burial to Manage Catastrophic Livestock Mortality August 1, 2020* but note that this method has not been validated for routine mortalities nor for disease outbreaks. The method includes site selection criteria and requirements for buffer distances etc.

Australian Pork Limited National Environmental Guidelines for Indoor Piggeries (NEGIP 2018) and Piggery Manure and Effluent Management and Reuse Guidelines 2015 provide details on mortalities management and provide environmental requirements regarding composting, burial and burning. This information could be utilised for incorporation into future guidance and research or where jurisdictions are silent on guidance.

5.2.9 Decontamination Guidance Materials

Queensland is the only State that has specific guidance regarding decontamination in their document *Procedural Guide- Incident Response 2.17 Animal Disease Outbreak Waste Management.* This document sets out the requirements for the various waste types expected for a major animal disease incident and include carcasses, infected solids, infected liquids and contaminated solids. Regarding effluent pond decontamination, Qld would require the piggery to follow their licence conditions re effluent and management and land application (if licensed) or industry best practice so not to cause pollution. In general, if not licensed, piggeries will need to ensure the general environmental obligations are met.

AUSVETPLAN Operational Procedures Manual Decontamination Version 3.2, 2008 has a section on environmental considerations with high-level outcomes. It outlines that it is a common requirement in all States and territories that activities should not have significant detrimental impact on the natural environment. It also notes that in some cases, it may be possible to release water into waterways following treatment to neutralise chemical disinfectants (for example, treatment of oxidising disinfectants with thiosulphate) or following a prescribed period of time that allows chemicals to dissipate to acceptable levels (for example, hypochlorite and chlorine dioxide). Other options could include discharge onto approved wasteland sites. The plan also provides an option for the use of temporary drains to trap and divert waste and for the use of lined ponds or tanks for temporary storage to reduce the adverse effects of decontamination activities on the environment.

The other States do not have any specific guidance on the environmental aspects/requirements regarding decontamination. Every jurisdiction indicated that storage and disposal would be determined based on the type and amounts of chemicals used. Some chemicals for example would generate little concern regarding contamination or pollution of the environment. Most jurisdictions indicated that it would be assessed on a case by case situation and the general environmental provisions/ duties would need to be met to ensure minimal impacts. There may be the potential to issue a licence for discharge to enter waterways in NSW, based on a case by case basis regarding chemical type and volumes. It was acknowledged by several States that there would be unique challenges in decontamination of an outdoor piggery.

It should be acknowledged that there may be other guidance documents regarding mass disposal and decontamination such as the DDD groups *Guideline for decontamination activities in an African Swine Fever response (Australia)* but these do not provide guidance at this time regarding siting and management from an environmental perspective.

5.2.10 Pre-preparedness

In many States, the EPAs and State government Agriculture and Biosecurity teams have indicated that they have been working with industry to strengthen biosecurity plans and identify options for disposal on a case by case basis in an attempt to facilitate pre preparedness and expedite the process in the event of an incident.

Victoria has a database of landfills and has developed SOPs including an incident report plan, guide for landfills, mass burial options analysis map and site assessment for mass burials. DJPR is also currently in the process of identifying a mass animal burial site on State government land.

QDES and QDAF in Queensland have indicated that they have been working with larger piggeries in identifying potential options and strengthening their biosecurity plans. QDAF have also developed a risk atlas to support a mass burial facility that includes the mapping of piggery locations.

New South Wales EPA has commenced mapping waste facilities and renderers in relation to piggeries and DPI NSW has identified some potential disposal options and mass disposal sites. State run exercises on ASF are also planned for NSW in late 2020.

In South Australia, PIRSA has undertaken land profiling and mapped preferable disposal sites across the State and undertaken consultation with the waste association, renderers, transport and livestock industries to identify potential disposal options. They have undertaken an ASF exercise on the State government run Roseworthy University of Adelaide campus and are planning another exercise in late 2020. They have also undertaken work with two major abattoirs on ASF disposal and decontamination plans and the FMD group have compiled a list of landfills in SA.

In Western Australia, DPIRD has been working with large producers to identify disposal options on a case by case basis. DWER also has a list of landfills available that they will use on a case by case basis. Operation Apollo has been run in WA on FMD which has provided valuable information for a disease outbreak. DWER has indicated that they are able to give pre-approval for potential disposal sites on farms as part of their licence conditions.

Pre-approval as a licence condition is an opportunity to be explored by industry however most States only licence piggeries above a size threshold creating limitations for smaller unlicensed facilities. Victoria doesn't licence piggeries. It was noted that the larger licensed sites are of smaller concern to the State agencies and EPAs as it is their view that the large piggeries usually implement high standards of biosecurity. The main risk was seen in the smaller piggeries or free-range operations that may not have the same level of resources and biosecurity or have higher risk of exposure to the feral pig population.

Table 1 Relevant environmental requirements in AUSVETPLAN and each jurisdiction.

	AUSVETPLAN	Victoria	Queensland	New South Wales	Western Australia	South Australia	Tasmania
Environmental legislation and guidelines	AUSVETPLAN Operational Manual Disposal Version 3.1, 2015 AUSVETPLAN Operational Procedures Manual Decontamination Version 3.2, 2008	*Environment Protection act 1970* *Environment Protection Amendment Act 2018* (will become *Environment Protection Act 2017*) EPA Publication IWRG641.1 Farm Waste Management – June 2019 Disposal of bushfire waste EPA Publication 1738 – March 2019 Guidelines for on-farm burial of animals in an emergency animal disease response – AGRICULTURE VICTORIA, 2020 DPJR Incident Action Plan- ASF Incident appreciation process (draft) Vic Identifying and activating a stand-alone mass animal burial facility guideline, 2020 (Off site) DJPR Carcass Disposal Options	*Environmental Protection Act 1994* *Waste Reduction and Recycling (Waste Levy) Amendment Act 2019* *Disaster Management Act 2003* DAF Establishing a mass burial facility for disposal of carcasses and material contaminated with an infectious emergency animal disease agent 24 May 2016 DAF Developing a risk atlas to support mass burial facility site selection in Queensland Procedural Guide- Incident Response 2.17 Animal Disease Outbreak Waste Management ABN 46 640 294 485 November 2019	*Protection of the Environment Operations Act 1997* *Protection of the Environment Operations (Waste) Regulation 2014* Animal carcass disposal December 2017, Primefact 1616, first edition, Animal Biosecurity, NSW DPI. Procedure – Disposal of large animals by Composting NSW DPI, Sept 2008 www.dpi.nsw.gov.au /climate and emergencies / emergency/ management/ resources and publications has a wide range of resources targeted at involved agencies including: •Task risk assessment for animal destruction and disposal activities in emergencies •animal-biosecurity-pig-field-investigation-questionnaire	Environment Protection Act 1986 Environmental Protection Regulations 1987 WA Ruminant and Pig Disposal Plan in the event of an EAD Version 6 18 January 2017 Internal doc only Incident appreciation process (draft) Vic DPIRD Livestock carcase disposal after fire, flood or drought www.agric.wa.gov.au not for carcase disposal of diseased animals but references in WA disposal plan for EAD DPIRD SOP- Disposal of carcasses in an EAD event using on site trench burial- internal doc 2017 DAF EAD SOP Mass Burial of Animal Carcases and other Materials in an Emergency Incident- Internal Document	Environment Protection Act 1993 Compost guideline, EPA SA June 2019 On-farm disposal of animal carcasses Updated February 20161 EPA 682/16: *This information sheet explains how to dispose of animal carcasses on farms and does not apply for carcasses from intensive livestock operations such as poultry (broiler or egg) farms, piggeries, cattle and sheep feedlots.*	*Environmental Management and Pollution Control Act 1994* *Environmental Management and Pollution Control (Waste Management) Regulations 2020* Emergency Burial of Carcasses- bushfires

		Analysis Map (Off site). _Site assessment for mass burial report Disposing of carcases and contaminated materials to licensed landfills Guidance Document, Victoria Government 2019 (Offsite) DJPR SOP Incineration of carcases using an above ground 'Burn Boss' air curtain incinerator 2020 – no environmental requirements Disposing of carcases after bushfire flood or drought AgNote Number: AG1371, Agriculture Victoria			DAF EAD SOP Assessment of land for disposal of carcasses using on-site trench burial-2016 – internal doc EAD list of putrescible landfills – internal doc Matrix of all disposal options and resources-internal doc DAF EAD SOP Application for exemptions under section 75 of the Environmental Protection Act 1986 (EP Act), 2026-internal doc		
Environmental Authorizations for emergency events under relevant State legislation	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Waste Levy Exemptions	N/A	Yes	Yes	Yes	Yes	Yes	No- *currently no waste levy applied. May come into effect 2021.*
EPA Role* **All can issue emergency authorizations for onsite disposal and for offsite facilities to accept**		Waste Disposal alongside DJPR Identify suitable disposal options- on and offsite locations and facilities Site by site basis DJPR Identifying 3 mass burial sites	Waste management alongside QDAF Identify suitable disposal options- on and offsite locations and facilities Site by site basis Working with larger piggeries in	EPA NSW responsible for waste management. Work alongside NSW DPI Identify suitable disposal options- on and offsite locations and facilities Site by site	Waste Management alongside DPIRD Pre-approval for disposal sites incorporated into licence Identify suitable disposal options- on and offsite locations and facilities	Waste Management alongside PIRSA Biosecurity Identify suitable disposal options- on and offsite locations and facilities Site by site basis	Waste Management working alongside Biosecurity Tasmania Identify suitable disposal options- on and offsite locations and facilities Site by site basis

waste-generally with conditions			identifying potential options to include in biosecurity plans- QDES	EPA Mapping waste facilities and renderers in relation to pig farms	Site by site basis Working with large producers on identifying options DPIRD List of landfills categorised on size available			
Disposal preference	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* Burial Burning Rendering Composting Other Alkaline hydrolysis Leave in situ Ocean Disposal Refeeding of non-susceptible species Appendix 8 provides a sample decision making process for determining appropriate disposal options	1) Off farm disposal to a licenced Landfill or renderer (can use unlicensed or closed) 2) On farm disposal if disease/scenario permits in accordance with guidance (Wastes on farms) 3) Pre-approved site- No current sites but DPI have identified 3 potential sites currently being assessed	1) On site disposal is the preference in accordance with disposal plan (DPI) 2) If transport allows a dedicated facility such as State-owned land operated to a temporary environmental licence (see below) and managed by an external contractor. *licensed disposal sites (landfills, incineration, composting, rendering) are an option but have limitation in QLD due to size and remoteness* *Because of the small size of most of the existing licensed disposal facilities in Queensland, it is highly unlikely that any would be appropriate*	1) Burial on site or (Landfill off site although burial not preferable but likely to happen) 2) Render 3) Landfill 4) Burning on site if manage virus and pollutants 5) Compost on or off site last on the list as there is a lack of science/evidence re pathogen survival and adequate management Primesafe note has Landfill off site as next preference to burial on site	Based on guidance internal doc 1) Burial on farm or Compost on farm 2) Local government composting or render 3) Landfill off site 4) Burial in greenfield site A decision tree (Section 5 of internal doc) will be used to guide decisions on the most appropriate of the four broad disposal options.	1) Preference is to a licenced EPA facility which is permitted to receive carcasses (or engineered facility) Some are not licenced/ normally suitable to receive they can issue an emergency authorization. Compost or renderer preferred over a landfill in accordance with waste hierarchy 2) On site disposal guided by AUSVETPLAN	EPA mentioned on site likely preferred Biosecurity Tasmania Offsite facility preferred 1) Burial on site if allowed 2) Burial offsite to landfill 3) Burning Offsite Compost on and offsite not a preference- lack of confidence in systems management and monitoring i.e. required temp to achieve destruction of virus in ASF case.

			for large scale events involving 1,000's of cattle equivalents.					
On site Burial requirements/ guidelines	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* High level objectives / considerations Not operational or prescriptive Appendix 6 Burial pit construction. Provides information on earthmoving equipment, burial pit construction and a calculation to determine how many animals per pit size	Yes Farm waste management Publication IWRG641.1 June 2019. Guidelines for on-farm burial of animals in an emergency animal disease response – AGRICULTURE VICTORIA, 2020 DPJR Incident Action Plan- ASF Disposing of carcases after bushfire flood or drought AgNote Number: AG1371, Agriculture Victoria Using on-farm burial suitability criteria (Carcass Disposal Options Analysis Map) Identifying and activating a stand-alone mass animal burial facility guideline, 2020 (Off site) DJPR Carcass Disposal Options Analysis Map- Site assessment for mass burial reports (Off site)	Yes DAF Establishing a mass burial facility for disposal of carcasses and material contaminated with an infectious emergency animal disease agent 24 May 2016 DAF Developing a risk atlas to support mass burial facility site selection in Queensland Procedural Guide-Incident Response 2.17 Animal Disease Outbreak Waste Management Attachment 9 – DES Criterion for land suitability for mass burials	Yes Animal carcass disposal December 2017, Primefact 1616, first edition, Animal Biosecurity, NSW DPI. www.dpi.nsw.gov.au /climate and emergencies / emergency/ management/ resources and publications has a wide range of resources targeted at involved agencies including: •Task risk assessment for animal destruction and disposal activities in emergencies •animal-biosecurity-pig-field-investigation-questionnaire	Yes DPIRD Livestock carcase disposal after fire, flood or drought www.agric.wa.gov.au not for carcase disposal of diseased animals but references in WA disposal plan for EAD WA Ruminant and Pig Disposal Plan in the event of an EAD Version 6 18 January 2017 Internal doc only DPIRD SOP- Disposal of carcasses in an EAD event using on site trench burial-internal doc 2017 DAF SOP Mass Burial of Animal Carcases and other Materials in an Emergency Incident- Internal Document DAF SOP Assessment of land for disposal of carcasses using on-site trench burial-2016 – internal doc EAD list of putrescible landfills	No PIRSA Case by Case situation General provisions of the act i.e. not pollute waterways etc. Take into consideration groundwater, neighbours etc Have undertaken land profiling to identify suitable sites. Prefer on farm to have identified sites On-farm disposal of animal carcasses Updated February 20161 EPA 682/16: *This information sheet explains how to dispose of animal carcasses on farms and does not apply for carcasses from intensive livestock operations such as poultry (broiler or egg) farms, piggeries, cattle and sheep feedlots.*	No No set guidelines. Assessed on a case by case basis. Would need buffers to waterways etc AUSVETPLAN would be used as a base. Bushfire Burial Guidelines could be used as a base. Emergency Burial of Carcasses

		Disposing of carcases and contaminated materials to licensed landfills Guidance Document 2019 (Offsite)					
On site Composting requirements	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* High level objectives / considerations Not operational or prescriptive	No No EPA Guidelines regarding emergency composting. No DPJR guidance.	No No Specific Guidelines regarding emergency composting.	Yes Procedure – Disposal of large animals by Composting NSW DPI, Sept 2008	Yes (no operational) Livestock carcase disposal after fire, flood or drought www.agric.wa.gov.au not for carcase disposal of diseased animals but references in WA disposal plan for EAD Provides no specific operational requirements but recommends input of a composting contractor. WA Ruminant and Pig Disposal Plan in the event of an EAD, Version 6 ,18 January 2017 Internal doc only When considering composting, if less than 20 pigs and a contractor with experience in composting pigs is available then the composting should be considered as a viable option.	Yes On-farm disposal of animal carcasses, EPA 2016 Will need to meet the requirements of a normal licenced composting facility. Compost guideline, EPA SA June 2019	No No set guidelines. Assessed on a case by case basis. Would need buffers to waterways etc Meet General Environmental duties
On site burning requirements	*AUSVETPLAN Operational Manual*	No	No	No	No No burning guidance	No	No

	Disposal Version 3.1, 2015 High level objectives / considerations Not operational or prescriptive Appendix 7: Pyre Construction Provides general information on pyre construction.	No EPA Guidelines regarding emergency burning. -No DJPR guidance for pyres DJPR SOP Incineration of carcases using an above ground 'Burn Boss' air curtain incinerator 2020- no environmental requirements	No Guidelines regarding emergency burning. Meet general environmental duty	Animal carcass disposal December 2017, Primefact 1616, first edition, Animal Biosecurity, NSW DPI. Refers to AUSVETPLAN		PIRSA Case by Case situation General provisions of the act i.e. not pollute waterways etc. Take into consideration groundwater, neighbours etc Have undertaken land profiling to identify suitable sites. Prefer on farm to have identified sites.	No set guidelines. Assessed on a case by case basis. Would need buffers to waterways etc Meet general environmental duties
AD	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* Estimated that digesters can handle 3.6 kg of meat per cubic metre of digester capacity per day.	No guidance	No guidance	No guidance	No guidance	No guidance	No guidance
Effluent and Manure Management **Decontamination**	AUSVETPLAN Operational Procedures Manual Decontamination Version 3.2, 2008 High level objectives / considerations Not operational or prescriptive	No guidance on decontamination-	Procedural Guide- Incident Response 2.17 Animal Disease Outbreak Waste Management Sets out requirements for Waste types for major animal disease incidents including: Type 1 – Carcasses. Type 2 – Infected solids. Type 3 – Infected liquids. Type 4 – Contaminated solids. Follow licence conditions re effluent management	No guidance- possibility to give licence to pollute waters but will be on a case by case basis i.e. how much chemical is used and what type is used. This will determine how to deal with it, how to detox and store.	No Guidance on decontamination	Effluent system decontamination- must meet general environmental duty	Remediation of land- no guidance May need to enact animal health act and biosecurity act. Animal health Act allows a direction to be put on property and they may require pigs not be on a site for X timeframe. Might be more necessary for an outdoor piggery in which it may be more difficult to decontaminate a paddock.

			and land application (if licence) or industry best practice so not polluting If no licence, follow general environmental duty				
Other AUSVETPLAN				*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* AUSVETPLAN Appendix 3 Enviro Checklist General			
Other APL Requirements Re Burial Composting and Burning and storage prior to render				*APL National Environmental Guidelines for Indoor Piggeries (NEGIP) 2018. – mortalities management (Not Mass)* *APL Piggery Manure and Effluent management and Reuse Guidelines 2015*			
Other -Decontamination DDD Group				*Guideline for decontamination activities in an African Swine Fever response (Australia)*			

5.3 AUSVETPLAN Environmental Requirements

The AUSVETPLAN Operational Manual Disposal Version 3.1, 2015 and AUSVETPLAN Operational Procedures Manual Decontamination Version 3.2, 2008 contain the nationally agreed approach for the response to an EAD incident in Australia. From an environmental requirement perspective, the AUSVETPLANs provide a high-level objectives approach to considerations with little detail on the specific requirements or operational aspects needed to achieve those objectives. Some jurisdictions do not have any guidance on some disposal methods such as composting and burning and default back to the AUSVETPLAN in the event of EAD. This approach will have limitations due to the lack of detail provided in the plan on how to operationally achieve the environmental requirements. In this scenario a jurisdiction will be working on a case by case basis, having to make decisions on the fly with no clear direction.

This can have not only potential impacts on the immediate environment and/or community but could also generate longer term legacy issues or timeframes for resolution of business.

As most of the jurisdictions use AUSVETPLAN as the basis of their guidance there is an opportunity to streamline individual State guidance material into a national approach to facilitate consistency between the jurisdictions. Considering the case by case nature and environmental differences of a site, a national approach would complement the emergency authorization powers of each jurisdiction which could if required vary the conditions of the guidance to suit a particular site or State. For example, if the national approach was to ensure all disposal is a minimum of 2 m above the highest water table and Qld wanted 5m due to a groundwater aquifer, this could be granted by an emergency authorization condition for that particular site.

5.3.1 AUSVETPLAN Operational Manual Disposal Version 3.1, 2015

The main body of the disposal manual provides several high-level environmental considerations for burial, with less detail on composting and burning. This level of detail is reflected in the State guidance which have more detailed information on burial with less or no guidance on composting and burning. The other less common methods of disposal listed in the manual such as anerobic digestion go into little to no detail on environmental considerations.

The appendices provide further detail on the environmental objectives through an environmental checklist which includes burial, burning, composting and landfill. However, they are again high-level and do not provide any detail on how to achieve the desired outcomes.

General information is provided in Appendix 6: Burial Pit construction and Appendix 7 pyre construction. The burial pit construction does not provide any ongoing or leachate management recommendations which was a key requirement from many jurisdictions with concerns for the leachate and virus entering groundwater systems. It was also bought to our attention by jurisdiction officers that there was some concern with the recommended burial pit volumes provided for the burial pit based on the animal numbers in the plan. The source of the information is unknown leading to concern that this would significantly overestimate the required burial pit volumes.

The anaerobic digestion capacity in AUSVETPLAN also appears to have limitations regarding pigs. It doesn't appear to take into account the high nitrogen content of the meat and the ammonia inhibition created by high N carcasses. This should be reviewed and updated to provide a N limit rather than mass.

5.3.2 AUSVETPLAN Operational Procedures Manual Decontamination Version 3.2, 2008

The Decontamination manual provides very high-level information on the environmental considerations regarding decontamination. This is also reflected in the lack of guidance from individual States. This limited guidance appears to be because most jurisdictions will assess the environmental requirements of decontamination on a case by case basis based on the type and volume of chemicals used. There is an opportunity to look at some of the common disinfectants and methods and assess the environmental implications and subsequent requirements. Most jurisdictions now default to the general provisions or duties of their relevant environmental acts.

For further information on the environmental information provided by AUSVETPLAN, please refer to Appendix A.

5.4 State Preparation and Documentation for an EAD

These sections assume the formation of an overall EAD response team as described above (Section 4.2).

5.4.1 Victoria

5.4.1.1 Role

During an EAD, the EPA in Victoria works alongside Department of Jobs, Precincts and Regions (Agriculture Victoria) to assist in the decision-making process regarding waste management and disposal both on and offsite. The EPA will assist in assessing suitable sites on the property and identify potential offsite facilities such as landfills (open (preferred) and closed) and composting facilities. EPA will facilitate this identification with the landholder.

5.4.1.2 Emergency Authorization

The EPA has the provision to grant emergency authorizations as described above (section 5.2.1). These provisions were recently enacted in Victoria during bushfire events, in which previously closed landfills were re-opened to receive dead stock. These sites although closed were preferred to an on-site burial as they already had established liners and leachate collection systems.

Under the current Act, the authorization is given as an emergency 30A approval. A new Act in 2021 means that any emergency provision will likely be granted as a section 157 approval. A s157 allows for the authorization of emergency storage and use of waste for the purposes of meeting a temporary emergency. This new legislation will have the same intent as the current 30A; however, the EPA believes there will also be the provision to provide for verbal approval rather than just in writing as is current process to speed up the response. Any authorized officer including regional officers can approve an emergency approval to expedite the process. An emergency approval will be given with guidance notes, forming the conditions of the approval.

For any on-site emergency approval, the disposal method will have to align with *the EPA Publication IWRG641.1 Farm Waste Management, June 2019*. However, this document is aimed at normal mortality events, rather than mass disposal situations. It also specifically states it is not for intensive livestock facilities and does not cover any other method of disposal other than burial. There is no EPA Victoria guidance on composting or burning in a mass disposal or EAD situation. Although this is the EPA's principle guidance document, it is not necessarily a hard and fast requirement as it is only meant to be a guideline. A site would be assessed on a case by case basis and a 30A approval could be used if an activity or action is outside the bounds of the guidelines. An emergency authorization overrides certain requirements based on the circumstances.

The EPA can also grant a waste levy exemption under s146 of the *Environment Protection Amendment Act 2018*. Under this provision, the Minister may waive the requirement to pay the waste levy for the purposes of the disposal of waste generated from a temporary emergency, such as a landfill accepting livestock disposal waste.

5.4.1.3 Disposal Preference

The stated preference for mass disposal is for movement of the material off-site to a landfill or renderer. Other options included on-site disposal on a case-by-case basis. Their last preference is to a pre-approved off-site location. At present there are currently no pre-approved sites in Victoria, however Agriculture Victoria has identified three potential sites on State Government land which are in the process of being assessed for their suitability. Burning, although acknowledged to be a potential option in certain circumstances, was linked to perceived risk based on the UK foot and mouth situation.

5.4.1.4 Guidance documents

The guidance used in Victoria by the EPA is the *EPA Publication IWRG641.1 Farm Waste Management, June 2019* which only covers burial or normal day to day mortalities and excludes intensive livestock facilities. Victoria also has a number of other guidance documents developed by DJPR (Agriculture Victoria) on disposal, mainly focusing on burial both on and off-site and an incident response plan which identifies a number of options across the Depopulation, Disposal and Decontamination (DDD) process. The recent *Guidelines for on-farm burial of animals in an emergency animal disease response – Agriculture Victoria, 2020* document developed by the Agriculture Victoria has more detail than the EPA document. The inconsistency in guidance across these documents could potentially create confusion.

There are no guidance materials in either agency for disposal by composting or burning in a mass disposal situation. The EPA noted that composting and burning were not highlighted during mass animal disposal exercises involving DDD and were not sure of what guidance would be used if these methods were deemed a suitable option. They believed Agriculture Victoria might have guidance materials on composting and burning but we found that not to be the case. There are DJPR *SOP for Incineration of carcasses using an above ground 'Burn Boss' air curtain incinerator 2020* but this SOP is more procedural and does not cover environmental considerations. There is also *EPA publication 1738 Disposal of bushfire waste- March 2019* but this does not cover intensive animal industries such as feedlots, piggeries, broilers and egg farms and sets stock limits such as 500 sheep and 150 cattle.

The lack of information on these options is often reflective of the preferences. If there is no guidance, the EPAs and other State government agencies don't have the confidence to implement especially in a time sensitive/critical situation.

5.4.1.5 Preparedness

The EPA and Agriculture Victoria have a database of landfills and have relevant Emergency preparedness (Animal Biosecurity) documentation including an incident report plan, guide for landfills, mass burial options analysis map and site assessment for mass burials. Agriculture Victoria is also identifying potential mass animal burial sites on State government land. Three State government owned research facilities have been identified for further investigation. The EPA is supportive of individual landholders identifying areas on their farm suitable for disposal regarding preparedness. Piggery sites are not licenced in Victoria making it more difficult to add a disposal site condition to any licence.

The EPA noted has expressed that they are not totally sold regarding mass animal burial (off-site). This type of facility/site would need to have pre-approval in the event of an incident mass animal burial. Prior to pre-approval they would need an EIS for each site and there would need to be appropriate controls implemented or available on site. No pre-approval for a site has been given to date, however they will consider it an option if all of the above can be met.

Further detail on Victorian requirements and guidance can be found in Appendix A.

5.4.2 Queensland

5.4.2.1 Roles

During an EAD, the Queensland Department of Environment and Science (QDES) work alongside the Department of Agriculture and Fisheries (DAF) and biosecurity Qld), regarding waste management aspects of an emergency mass disposal incident. They identify suitable on-site locations and offsite facilities. In most events DAF/Biosecurity Qld will be the ones on the ground and QDES will undertake a desktop assessment of suitable sites using aerial photography, mapping and data systems.

5.4.2.2 Emergency Authorization

QDES has the provision to grant emergency authorizations as described above (section 5.2.1). These are outlined under the Environmental Protection Act 1994, Section 467. Section 467 grants the power for an authorized person to take or direct someone to take action to deal with an emergency through an emergency direction. The emergency direction may have conditions imposed. The direction can be given orally or by written notice, however the direction must be confirmed in writing as soon as practicable. A temporary licence under part 4A may also be given for an applicable event that was not foreseen. Such a licence may be granted in the event that a purpose-built facility is needed to deal with a mass disease outbreak. For example, QDES may grant a temporary licence for a landfill to be set up and operated on State government owned land. This operation would likely be sub-contracted to a suitable commercial company, with experience in managing such systems. QDES would act in an advisory role.

Schedule 1 of the *EP Act* also outline exclusions relating to environmental nuisance or environmental harm. Part 2 relates to Government activities and environmental nuisance caused while performing a function under the Disaster Management Act 2003.

The Disaster Management Act 2003 defines the meaning of disaster as a serious disruption in a community, caused by the impact of an event, that requires a significant coordinated response by the State and other entities to help the community recover from the disruption. The meaning of an event includes an infestation, plague, or epidemic with the example of an epidemic as a prevalence of foot-and-mouth disease.

Under the *Waste Reduction and Recycling (Waste Levy) Amendment Act 2019* a waste levy exemption can be granted by QDES for disaster management waste. Under section 26 of the Waste Reduction and Recycling (Waste Levy) Amendment Act 2019 *a* disaster management waste is defined as an exempt waste. *The Disaster Management Act 2003* provides the definition of a disaster and the meaning of an event including infestations, plagues, and epidemics.

5.4.2.3 Disposal Preference

The QDES stated preference is for on-site disposal methods. The preference for on-site disposal is due to the limited capacity of licensed off-site facilities in Qld (landfill, incineration, composters, renderers) and to reduce the potentially long transportation involved. Due to the small size, remoteness, and limited capacity of most of the existing licensed disposal facilities (landfill, incineration, composters, and renderers) in Queensland, it is highly unlikely that any would be appropriate for large scale events. A second preference is the disposal of carcasses to a dedicated off-site facility such as a State-owned landfill site operated under a temporary licence. QDES stated that they are flexible regarding on-site disposal plan methods.

Burial appears to be the current standard method of disposal of carcasses on site in accordance with the DAF disposal plan but they have no preference and are flexible regarding on-site disposal methods. QDES are outcomes focused and keen to know about other potential disposal methods beyond the standard practices to enable them to better assess the appropriate method for each site. They have a strong focus on risk and if there is a novel method that presents the least risk they would consider using if the outcomes are no worse than current standard methods.

5.4.2.4 Guidance

Guidance material has been prepared by DAF and QDES and cover similar topics on disposal, such as burial. QDES Procedural Guide- Incident Response 2.17 Animal Disease Outbreak Waste Management also sets out the requirements for disposal all wastes types generated in an EAD event. It lists the likely waste types from an EAD, including infected solids and liquids, contaminated materials, and general wastes. The documents also include a list of contractors contracted to transport and receive wastes for disposal for each of the waste categories

Disposal guidance documents from DAF, such as *Establishing a mass burial facility for disposal of carcasses and material contaminated with an infectious emergency animal disease agent 24 May 2016* and *Developing a risk atlas to support mass burial facility site selection in Queensland* and the QDES *Procedural Guide-Incident Response 2.17 Animal Disease Outbreak Waste Management* based on AUSVET national guidelines. These State documents altered some relevant operational requirements to suit Qld specific situations, such as a requirement for a 5m depth from burial pit to groundwater and the addition of porous materials to the bottom of burial pits to capture run-off.

There are no specific operational guidelines regarding emergency composting, burning or other disposal methods from either agency. Composting and burning must meet the general environmental duty/provision of the *EP Act* in that it must not pollute the land, water, and air.

Queensland is the only State that has some guidance on decontamination and dealing with infected products from a disease situation. *The QDES Procedural Guide- Incident Response 2.17 Animal Disease Outbreak Waste Management* sets out the various waste types including infected solids and liquids, contaminated materials and general wastes and provides a list of contractors who have been contracted to transport wastes and facilities engaged to receive wastes for disposal for each of the waste categories.

Chemical use regarding decontamination and effluent ponds (washed into the system) would be assessed on a case by case basis and would need to adhere to the general provisions of the *EP Act* re contamination. If licenced piggeries should follow their licence conditions re effluent management and land application so not to pollute. If not licenced, industry best practice is expected, and effluent must be managed in accordance with the general duties/ provisions of the Act. QDES may require NPK effluent tests to demonstrate suitability for land irrigation.

5.4.2.5 Pre-Preparedness

State agencies have been working with larger piggeries in identifying potential options and strengthening their biosecurity plans. For example, QDES have examined specific sites, soils, and hydrology to identify suitable burial pits. DAF have also prepared the guidance document *Developing a risk atlas to support mass burial facility site selection in Queensland* to support a mass burial facility that includes the mapping of piggery locations. This depicts the localities of high-risk enterprises e.g. piggeries, feedlots, sale yards, dairies and unallocated State land in the vicinity of high-risk enterprises, suitable for use as mass disposal sites based on characteristics such as location, geology, hydrogeology and topography. The risk atlas criteria for disposal were derived from the AUSVETPLAN Operational Manual: Disposal Procedures 2015. The atlas identified areas within 100km to all feedlots and piggeries in Qld, along with a number of other criteria such as areas of low to moderate groundwater vulnerability, areas away from flood prone areas and slope of the land less than 6% to name a few.
Further detail on Queensland requirements and guidance can be found in Appendix A.

5.4.3 New South Wales

5.4.3.1 Roles

During an EAD, EPA NSW is responsible for the waste management aspects of identifying suitable on and offsite disposal options. The State Department of Primary Industries aims to involve and inform industry as much as possible during the event especially as industry have a cost share interest. During the last AI outbreak NSW DPI worked with staff to ensure some ownership and control of the situation.

5.4.3.2 Emergency Authorization

The EPA has the provision to grant emergency authorizations as described above (section 5.2.1). Under the EPA Act, part 9.1 exemptions, s284 describes exemptions by the EPA in emergencies and other situations. The EPA may exempt any person or class of persons from any specified provision or provisions of the Act or the regulations, in the circumstances referred to in subsection (2). These sub sections include an emergency (including, for example, fires, floods and fuel shortages) or if the EPA is satisfied that it is not practicable to comply with the relevant provision or provisions, by implementing operational changes to plant or practice or if the Board of the EPA approves the granting of the exemption.

A waste levy exemption can be granted under the Protection of the Environment Operations (Waste) Regulation 2014. Part 2 Division 5 Clause 21 specifies that certain types of waste are exempted from calculation of contributions These include any waste collected in accordance with a community service or activity, or arising from a biological outbreak or natural disaster, It should be noted that the waste levy is not charged in all landfills and is likely to be charged along the coast and not inland where most of the piggeries are located.

5.4.3.3 Disposal Preference

The State agencies stated a preference for on-site methods for mass disposal of pig carcasses. In this scenario burial was most likely to be the method implemented even though it was acknowledged as not being the best method from an environmental and disease perspective. A second preference is for the disposal of carcasses to a rendering facility acknowledging that this is less likely to occur than the third preference of off-site Landfill due to the capacity and operational requirements of rendering facilities. Other options included burning on-site or composting on-site or off-site. The EPA is concerned that there is a lack of science or evidence regarding pathogen survival and management of composting sites for pigs, particularly compared to poultry disposal.

Note the NSW DPI Primesafe document had Landfill off site as the second preference which is similar to the EPA. NSW DPI also mentioned that they are not wedded to any particular method. For poultry they mentioned rendering is the first preference, followed by compost on and offsite, burial and then landfill with less preference for burial (active AI found in burial after 15 years). This reflects the differences in industries and carcass type with purpose-built poultry renders and substantially more operational guidance on mass poultry composting. It was mentioned that NSW DPI has seen price gouging with renders accepting poultry wastes in an emergency. The cost option is important as there are various parties involved in cost sharing. If expensive, then government must answer to industry and often a cheaper but inferior disposal option is chosen from a political standpoint.

Burning is an option especially high temperature incineration i.e. side curtain or air curtain burners. There is a company in Wollongong, but the EPA is keen to do more research or get more efficacy data. Auxiliary facilities such as aluminum smelters (incineration) could be an option. They are not licensed to release gases from ions in carcass degradation but burn at high temps. An emergency licence could be granted to allow the activity.

New South Wales would rapidly run out of landfill space if they needed to dispose of a couple of million pigs which is much the same situation with FMD. Post fire clean up saw sites running out of space. Volume is going to be an issue. A broad plan is needed. The possible use of renderer facilities has faced issues with cost fluctuations and lack of experience with pig carcasses. Cost fluctuations are important in cost-sharing situations.

The possible use of landfill sites has faced issues with available space. For example, carcass disposal generated by bushfires filled several landfills. The NSW agencies have examined other disposal options such as incineration in commercial aluminium smelters, or on-site air curtain incinerators.

5.4.3.4 Guidance

Guidance materials and protocols for carcass disposal have been developed by NSW Department of Primary Industry include *Animal carcass disposal December 2017, Primefact 1616, first edition, Animal*

Biosecurity, NSW DPI and *Procedure – Disposal of large animals NSW DPI, Sept 2008*. These documents are a hybrid of their own material and AUSVETPLAN. Animal carcass disposal covers construction, management, disease issues and transport issues for disposal sites. They also indicate environmental requirements, such as buffer spaces to waterways. New South Wales is one of the only States having specific composting guidelines for carcasses. The document Procedure – Disposal of large animals by composting NSW DPI, Sept 2008 includes resources, equipment, warnings, preparation, construction, management, post compost management. It also includes environmental requirements re buffers

Other guidance documents for depopulation and disposal targeted at State agency staff can be accessed at https:// www.dpi.nsw.gov.au /climate– and-emergencies. These cover such topics as risk assessments for animal destruction and disposal activities in emergencies, animal biosecurity pig field investigation, risk-assessment use of firearms in emergencies and destruction of animals using carbon dioxide.

Burning is mentioned very briefly in the document *Animal carcass disposal December 2017, Primefact 1616, first edition, Animal Biosecurity, NSW DPI.*, however it refers to AUSVETPLAN and does not provide any specific environmental or operational requirements.

No guidance is available for decontamination. It was mentioned that there is a possibility to issue a licence to pollute waters, but this will be assessed on a case by case basis, i.e. type of chemical and volume. This will determine how to deal with it, how to detoxify and store. The general provisions/duties of the Act will likely need to be met.

5.4.3.5 Preparedness

The DDD team in NSW is currently working on preparedness activities, including the investigation of other disposal options such as mining sites and grinding options for carcasses. They encourage piggeries to have individual disposal plans. The EPA is mapping relevant waste facilities and renderers in relation to the locality of pig farms. This is likely to be in relation to licensed piggeries i.e. over 2000 pigs.

The NSW team is interested in other disposal options such as mulching/grinding pigs but hasn't done the research to be confident that there is biodegradation of the virus, especially with ASF. The agencies have had preliminary discussions around alternative approaches such as the impact of change of acidity on the virus. i.e. mine tailings dams have the acidity and are already contaminated sites. They have also been talking to the SA poultry industry about the methods/options but are questioning the science around some of the options. The agencies have also identified a couple of potential mass disposal sites in NSW but at this stage the major limitation appears to be transportation.

In order to assist in preparedness, NSW see table-top exercises and run State exercises as key to learning how to deal with an event. Unfortunately, COVID-19 has interrupted work on planned exercised at this point in 2020. During these exercises NSW will run through the decision-making issues and questions and identify any problems with the process.

Further detail on NSW requirements and guidance can be found in Appendix A.

5.4.4 Western Australia

5.4.4.1 Roles

During an EAD, the WA DWER is responsible for the waste management aspects in relation to the identification of on and offsite locations and facilities. They take a secondary role working alongside the Department of Primary Industries and Regional Development (DPIRD) who would declare an emergency. Once an emergency is declared emergency exemptions can be granted by the CEO along with waste levy exemptions. The DWER can also grant pre-approval for disposal sites on individual farms. If DWER deem an identified disposal site suitable it can be incorporated onto the piggery licence for potential use in the event of a mass disposal event.

5.4.4.2 Emergency Authorization

The DWER has the provision to grant emergency authorizations as described above (section 5.2.1) under the EP Act, Part V Environmental regulation, Division 5 Miscellaneous s75 Discharges or emissions in emergencies. An occupier of a premises may be granted exemption from compliance subject to conditions. This exemption may be granted to meet a temporary emergency. The DWER will take advice from the relevant authorities such as DPIRD as to what constitutes an emergency. This can then trigger the exemption clause in the *EP Act.*

The *Environmental Protection Regulations 1987* Exemptions from this Part; refunds etc. of levy allow for an exemption for an approved waste that has been disposed of in an approved manner or the Chief Executive Officer may, by written notice grant an exemption subject to conditions or limited to circumstances.

5.4.5 Disposal Preference

The stated DWER preference is for mass carcass disposal by on-site burial or composting. A second preference is for off-site disposal to a local government composting facility or rendering plant. Landfill offsite is the next preferred option followed by burial in a greenfield site. Burning was not considered an acceptable preference due to public perception issues (FMD UK referenced).

A decision tree in section 5 of *WA Ruminant and Pig Disposal Plan in the event of an EAD Version 6 18 January 2017* will be used to guide decisions on the most appropriate of the four broad disposal options listed above. The appreciation process adapted from the Victorian DPI disposal/risk assessment process considers a list of factors including pros and cons and allows options to be determined in a systematic way.

The disposal options in WA are complicated by local regulations covering site contamination. The DWER may classify a farm site as possibly contaminated requiring further investigation if they believe a site may cause contamination generated by an EAD event. If an investigation then finds the site not to be contaminated, then the classification is lifted. However, if the site is deemed to be causing contamination, the site would be listed as contaminated and a subsequent contamination investigation and remediation process will need to be undertaken. This process is costly, requiring auditors, registered contaminated sites consultants, site investigations, mandatory auditing reports, and a remediation action plan and subsequent remediation. The use of burial pits without liners in WA is therefore not considered a feasible option for mass disposal under these DWER regulations. This goes against the published DPIRD decision tree which lists on-site disposal burial pits or composting options.

5.4.5.1 Guidance

There are guidance documents produced by DPIRD or Department of Agriculture and Food (DAF-previous department to DPIRD) relating to disposal of carcasses, but only the *DPIRD Livestock carcase disposal after fire, flood or drought* is publicly available. All other documents are internal SOPs or guidance documents aimed at decision makers i.e. State government agencies. Most of these documents focus on burial.

The publicly available *DPIRD Livestock carcase disposal after fire, flood or drought* outlines several environmental requirements including buffers to groundwater and waterways. It also sets out pit dimensions in line with AUSVETPLAN requirements. The document states that it is not for carcass disposal of diseased animals, however it is referenced in the WA Ruminant and Pig Disposal Plan in the event of an EAD document.

The WA Ruminant and Pig Disposal Plan in the event of an EAD document refers to other internal SOPs for burial requirements including the following;

- *SOP Assessment of land suitability for burial of carcasses for disease management on private land*
- *Spreadsheet Matrix of all disposal options and resources*
- *SOP Disposal of carcasses using on-site trench burial*
- *SOP Transport of carcasses and contaminated material*
- *SOP Mass Burial of animal carcasses and other materials in an emergency incident*
- *Spreadsheet: Complete list of all commercial disposal sites.*

The documents *DPIRD SOP- Disposal of carcasses in an EAD event using on site trench burial, DAF SOP Mass Burial of Animal Carcasses and other Materials in an Emergency Incident- Internal Document and DAF SOP Assessment of land for disposal of carcasses using on-site trench burial* all outline environmental burial requirements. Although they are all referenced as guidance documents in the WA Ruminant and Pig Disposal Plan in the event of an EAD, the documents are of varying ages and are inconsistent in their environmental requirements. These inconsistencies could lead to potential confusion regarding environmental requirements for disposal in WA documents.

Not having consistent information or information on environmental requirements publicly available to industry may be to the detriment of producers who potentially want to identify suitable sites for mass disposal.

The DPIRD Livestock carcass disposal after fire, flood or drought and the *WA Ruminant and Pig Disposal Plan in the event of an EAD* both mention composting as an option but do not provide further guidance on environmental or operation management on site. The WA Ruminant and Pig Disposal Plan in the event of an EAD mentions that composting is a viable option for less than 20 pigs or if a contractor with experience in composting pigs is available then the composting should be considered. There is no guidance on burning or anaerobic digestion.

There is also no guidance on decontamination with it being assessed on a case by case basis. Like other jurisdictions it would need to comply with the general provision of the *EP Act* or any emergency approvals.

5.4.5.2 Pre-Preparedness

The DWER encourages piggeries to identify suitable sites for mass disposal and get agreement from DWER on the suitability. The DWER may then grant pre-approval for disposal sites on individual farms by incorporating the location into the piggery licence as a condition.

The DWER also has a list of landfills (categorised on size) available to assist in identifying facilities that they may use on a case-by-case basis.

The DPIRD has to date worked with 10 representative WA piggeries and Linley Valley Abattoir to develop site specific disposal plans. The piggeries range from large conventional piggeries to free range operations. The exercise involved collaboration with producers to identify on and off site disposal options for each site using the decision tree in the WA Ruminant and Pig Disposal Plan and various mapping and data sources, i.e. is the site suitable for burial, if not is composting viable or are off site options required. They noted that some sites did not have suitable locations or have too many pigs for on-site disposal methods. This exercise identified the disposal challenges for WA agencies and highlighted that it is a complex and complicated process. For the development of the individual site plans they are.

The DPIRD acknowledged a good relationship with the WA pig industry and pig vets in the State. It was noted that WA is a slightly different to the eastern States as most of the industry players know each other and there is a degree of trust due to their isolation. This is unique to WA compared to the other States that have a lot of cross State interactions e.g. for slaughter. Western Australia noted that large piggeries generally have good biosecurity plans and are at a much lower risk than the smaller operation such as free range.

Operation Apollo provided valuable information for a WA disease outbreak, in the absence of actual EAD events.

The 20 highest risk local government authorities in WA have supplied a list of potential disposal options in their area. Their options will be risk assessed to determine their capacity and suitability for a mass disposal event.

A list of State-wide contractors of services required for effective disposal will be maintained by DPIRD through its connection to Main Roads and their obligations under WESTPLAN – ANIMAL AND PLANT BIOSECURITY.

Further detail on WA requirements and guidance can be found in Appendix A.

5.4.6 South Australia

5.4.6.1 Roles

During an EAD event, the EPA is the referral agency under the State emergency committee responsible for waste management. The main role in a disease event will be the PIRSA Biosecurity team. The EPA consider a mass disposal incident in pigs the same manner as bushfire death incidents or poultry EAD events as the principles are the same. During an EAD, the department of Primary Industry for South Australia (PIRSA) aims to work together with the producer to identify available resources, location and disposal options. Approval of the disposal method will be done in consultation with EPA and disease experts.

5.4.6.2 Emergency Authorization

The EPA has the provision to grant emergency authorizations as described above (section 5.2.1). Under part 12 of the Environment *Protection Act 1993* - Emergency authorizations s105 allows for the EPA to issue in writing an authorization allowing an act or omission that might otherwise constitute a contravention of the Act. This will be granted if the if the EPA SA is satisfied that the circumstances of urgency exist such that it is not practicable for the person to obtain an exemption. This activity may be carried out on-site, e.g. on-site composting, or off-site at a facility not normally able to accept or handle the waste due to licensing requirements or other regulations.

Also, under the *Environment Protection Act 1993* Miscellaneous part 15 s116 The EPA or other administering agency in cases of kind approved by the minister can waive the payment of, or refund, the whole or part of a waste fee or levy. EPA would provide the case in kind for the minister's consideration and approval. A case in kind allows the action to be applied to an incident or event to avoid setting a general precedent, EPA are currently investing ways of how the waivers can be applied more generally i.e. emergency disease situation.

5.4.6.3 Disposal Preference

The stated preference in SA for mass disposal of pigs is for off-site disposal to a licensed or engineered EPA facility permitted to receive carcasses. The EPA can also issue an emergency authorization for an unlicensed facility. A compost or rendering facility is preferred over a landfill site in accordance with the waste hierarchy. The second preference is for on-site disposal guided by AUSVETPLAN. There was concern from the EPA that there could be serious impacts if individuals composted on farm without implementing measures normally required by a licensed composter.

Consultations by PIRSA with local renderers has led to statements that the renders would not accept material unfit for human consumption. Local renderers are considered of limited size or suitability for mass disposal of dead pigs. A large SA poultry render facility indicated it is unable to take pigs as it will affect their export market.

The PIRSA indicated that composting of dead pigs could occur on a nearby arable farm, enabling end product use as a soil conditioner and fertiliser. Composting contractors could assist with site design, management and monitoring to provide greater confidence to EPA and State agencies. It was also suggested a commercial composter could remove the material after an initial composting phase for further and secondary processing phases.

The PIRSA preference is for on-site disposal due to the complexities of transport, lack of options for an off-site mass disposal sites (i.e. big hole) and public perception associated with mass (one site) disposal sites re smoke in the UK with FMD. The PIRSA preference: On farm composting, burial and burning being last on the list. Small piggeries may be able to have small incinerators. Above ground burial was viewed as an option but there was concerns from PIRSA regarding disease spread by vermin. PIRSA was concern that the EPA may want a disposal site to be set up like a landfill and take 6 months to plan.

5.4.6.4 Guidance

The guidance document *On-farm disposal of animal carcasses, EPA 2016* outlines the requirements for selecting a shallow, trench burial or composting disposal site. Note this document is not meant to apply for carcasses from intensive livestock operations such as poultry (broiler or egg) farms, piggeries, cattle and sheep feedlots, however, it is the only guidance information for the State. It should be mentioned that SA is the only State that has the same environmental requirements for both burial and composting. Most States only have requirements for burial and remain silent on-site requirements for composting and burning.

Although it is not expected that a site will be able to set up to the standards of a commercial composting facility or meet the licence thresholds for composting, it is expected that an emergency compost site would meet the general requirements of the *Compost guideline, EPA SA June 2019*. An example of mass disposal occurred during a recent ILT outbreak. The EPA received a complaint that a compost facility not licensed to receive carcasses was receiving infected litter and carcasses. It was investigated further and found that Biosecurity SA had asked them to receive the waste due the proximity of the facility to the infected farm. The location of the facility meant that the material being transported avoided passing other chicken farms and potentially spreading the disease. Although unlicensed and not having the exact requirements expected from a compost facility, the EPA permitted an emergency authorization to allow the site to continue to receive the material. The EPA is currently working with the facility to upgrade their licence so they can receive similar wastes in the future. This is a good example of the use of an emergency authorization but also highlights the need for communication between State agencies in an EAD.

There were no specific guidance documents for onsite burning, anaerobic digestion or other disposal methods with each site being assessed on a case by case situation. It is expected that any activities meet the general environmental provisions/duties of the EP *Act* i.e. not pollute surface waters, groundwater, air, and land.

There was no guidance on decontamination with, again, the general provisions of the *EP Act* being the requirements to be met.

SA acknowledged that the disposal options will be easier for smaller piggeries even though they will have the same environmental requirements. For example, they would need considerably less co-composting material.

The South Australian agencies stated a strong preference for disposal methods listed in AUSVETPLAN. If a mass disposal method is not approved in AUSVETPLAN it will not be used in SA. AUSVETPLAN considers environment, government and animal welfare. No alternatives will be considered as they may not have gone through the same assessment and review process as per AUSVETPLAN.

5.4.6.5 Preparedness

The PIRSA have undertaken land profiling using MCass multi criteria analysis i.e. groundwater, soil type, access roads, and mapped preferable disposal sites and areas to avoid. Groundwater was found to be the biggest issue especially in Southeast SA which has shallow groundwater. Access to good data was noted as an issue in some areas. As mentioned, PIRSA have also undertaken consultation with the renderers association and the waste, transport, and livestock industries. Consultation with the waste industry has indicated that landfills capable of receiving dead pigs are located close to urban areas and likely not a suitable option for piggeries. These landfill facilities also had business continuity issues, such as the need to need for truck disinfection, limited road access and diversion of trucks to other landfills to maintain regular collection services. A commercial medical incinerator was identified but had limited capacity and would be unable to service a mass disposal event. Timing was raised as an important consideration in the development of a disposal site but difficult to manage. An example of digging a pit outlined that the first 3 m of excavation was easy and then became slower and more difficult the further down the soil profile.

The PIRSA is aware of many day-to-day operations with methods that could be potentially adapted to an emergency situation on other sites. One such example was at a saleyard which use passive composting on mortalities with bays or windrows which could be lengthened in the event of additional stock.

The PIRSA has encouraged farms to identify potential disposal sites to assist in preparedness and expedite the process in the event of a mass disposal incident. The more detail provided in the plan the better.

The PIRSA has also undertaken work with two major abattoirs on ASF disposal and decontamination plans, which includes cleaning an affected facility and disposal of lairage pigs. It is identified that abattoir cleaning is a daily current practice, but cleaning of lairage and effluent areas would be more difficult.

The PIRSA FMD group has compiled a list of landfills in SA. This list along with local council closed landfills would be utilised in an EAD outbreak.

Practical issues for burial disposal were identified, such as calculation of the correct pit size. The PIRSA have identified the need to review the burial volumes as set out in AUSVETPLAN. There appears to be an overestimate of the volume needed for cows, sheep and pigs and lack of a reference sourcing this data. There is strong support for a biomass calculator to assist in determining pit volumes and composting requirements.

The PIRSA is supportive of the recommendation in the FMD project that there should be trained subject matter experts to assist in the event of a mass disposal incident i.e. a compost expert who knows siting, design, management and monitoring requirements. This information can form part of policy documentation.

The PIRSA held an ASF exercise on the State government run Roseworthy campus 400-sow farrow to finish piggery to determine appropriate resources (teams) to depopulate and disposal options. PIRSA are planning to undertake another exercise later in 2020 on a hypothetical scenario in which a farm tests positive. This exercise will allow then to plan the disposal method and identify sites.
EPA SA is part of a State-wide carcass working group.

Further detail on SA requirements and guidance can be found in Appendix A.

5.4.7 Tasmania

5.4.7.1 Roles

During an EAD event, EPA Tasmania would work with Biosecurity Tasmania regarding waste management in the event of a mass disposal event. They will identify on site disposal sites and off-site facilities. If it was a major incident the EPA might also work with local council authorities in identifying suitable sites or facilities.

5.4.7.2 Emergency Authorization

The EPA has the provision to grant emergency authorizations as described above (section 5.2.1). Under division 5 Emergency authorizations, s34 emergency authorizations, the EPA can authorize in writing an act or omissions that might otherwise constitute a contravention of the act, if they are satisfied that circumstances of urgency exist.

Tasmania currently does not apply a waste levy. Under new draft legislation a waste levy may come into effect in 2021. However, landfills do charge a fee and if carcasses were sent to a landfill, the EPA may be able to negotiate a reduced fee. This would also be applicable to any composting or waste facility.

5.4.7.3 Disposal Preference

EPA Tasmania stated that on-site burial disposal is their preferred option. Biosecurity Tasmania's preference was for disposal to an offsite facility followed by on site burial if the site allows. The next favoured preferences were off-site disposal at a landfill and burning off site (significant limitations due to proximity of neighbours). Composting on or offsite was not a considered a preference, due to the lack of confidence in systems management and monitoring i.e. required temperatures to achieve destruction of the virus in an ASF case. The use of the end-product was another concern. The classification and restricted use of the end-product material and land used to receive product is unknown. This consideration is an essential upfront issue even though it occurs at the end of the process. The consideration of end use requirements and classifications was deemed to take up a lot of administration effort and was thought to be not an effective use of time and effort in an EAD. Thus, burial on site is the top preference as the end use of the product and associated process is not a consideration. If composting is to be undertaken in an EAD it would likely occur at commercial composting facility. However, Biosecurity Tasmania deemed that there would be the same concerns for onsite composting regarding adequate monitoring and temperature controls to eliminate the virus. If the materials were not infected with ASF, commercial composting would be a suitable option as these facilities in Tasmania currently receive salmon waste and commercial spent hens. The support for composting as an option would depend on the disease and site-specific requirements. There was seen to be sufficient expertise in the State on composting. It was noted that EPA also had concerns about composting as an option. There was also concern regarding burning and the social and public perceptions regarding the UK FMD situation.

It was also noted that the burning and incineration had significant limitations. The available land and season/time of the year would be key factors in determining viability. For example, it was mentioned that bushfires are a concern in Tasmania and for 6 months of the year burning would unlikely be a viable option. It was also mentioned that Tasmania has ample feedstocks for burning and composting on or off site but in winter there would be constraints on spreading due to land availability.

In general, land availability, space and proximity of neighbours was another constraint identified by Biosecurity Tasmania which limits the disposal options available to them.

Biosecurity Tasmania are open to different options regarding destruction and disposal so long as they are practically feasible and socially acceptable.

5.4.7.4 Guidance

There are no specific guidelines on burial of carcasses in a mass disposal or disease event for Tasmania. Requirements would be assessed on a case by case basis and would need to maintain appropriate buffers to waterways etc. and meet the general environmental duties of the *EP Act* i.e. not pollute the land, surface waters, ground water and air. The AUSVETPLAN manual for disposal would be used as a basis. It was acknowledged that AUSVETPLAN is not operationally focused but that they must be used during a response.

The guidance document *Emergency Burial of Carcasses* developed for the recent bushfires could also be utilised. This document outlines environmental requirements to prevent any contamination of surface or ground waters and subsequent risk to human and animal health and to the environment. It includes information on suitable location, buffers, and pit management.

There are no specific guidelines on composting, burning or anerobic digestion.

There are no guidance documents on decontamination of the land or effluent ponds. They would need to meet the general requirements of the *EP Act*. The type of chemicals used will determine the decontamination process. Wash waters would likely be stored and assessed on a case by case basis and any land application withheld until dry weather. For example, if Virkon was used there would be no real concerns as it does not take long to break down in the environment.

There has been the exploration of the disposal of milk option to dispose of contaminated materials into the class 2 sewage plants and into the sea as part of an emergency response. It would be a one-off solution and diluted in large volumes. This could be an option to dispose of contaminated materials from a decontamination event.

5.4.7.5 Pre-Preparedness

Biosecurity and EPA Tasmania are part of an emergency response teams and are considered well-connected and trained. Training for large oil spill responses has been enacted and the process is seen to be transferable to any emergency response. This process was recently enacted for an actual EAD response to a major fish mortality incident. The pig industry in Tasmania is recognised to be small and little specific preparedness has occurred.

Biosecurity Tasmania have explored the disposal of milk to a class 2 sewage farm and out to see as a dilution method of disposal as well as assessing other off-site options. Existing licenced facilities at Dulverton and Copping have been explored as potential options in the event of a mass disposal incident. They have also identified a large composting facility at Interlarken.

Biosecurity Tasmania have also mapped a couple of greenfield sites, including an army land site, however access was determined to be an issue. During a recent FMD response exercise for multiple species it was determined that most of the cattle in Tasmania are located to the North where ground conditions make digging holes difficult. Livestock in the North West of the State would likely go to Dulverton as the area has high water tables making burial unviable. It was noted that Tasmania in general lacks thick soils.

Biosecurity Tasmania supports the development of operational disposal plans with identification of suitable areas on farm.

As a "smaller" State, Tasmanian officials viewed the guidance material and operational materials of other States as able to be utilised, but a national approach is preferred to create consistency.

Further detail on Tasmania requirements and guidance can be found in Appendix A.

5.5 Conclusions

5.5.1 Key Implications

- AUSVETPLAN is used as the basis of all State guidance which provides high level objectives and minimal operational material.
- Many jurisdictions apply the same principles, processes and methods to pigs as they do other livestock whereas there needs to be different approaches and methods for the different animal species due to the size and complexities of each industry i.e. not a one size fits all approach.
- Burial which has the most focus in the AUSVETPLAN is reflected in burial on-site being the preferred method for the majority of the States.
- Burial and an out of site out of mind mentality is prevalent amongst decision makers without taking into account key considerations such as timing, pig sizes and legacy implications.
- AUSVETPLAN lacks operational guidance leaves it up to the States to develop their own materials and SOPs which creates national inconsistencies. It was noted that the smaller jurisdictions are utilising larger State guidance materials to encourage consistency and minimise reinventing the wheel.
- Inconsistencies exist in the guidance material across and within States.
- There is a lot of information produced by individual State agencies, however the majority of this information is for internal use and targeted at decision makers only.
- Little guidance material exists for producers to assist them with preparedness requirements and options.
- There is a lack of guidance material for the pig industry on composting and burning which results in a lack of confidence in the methods as a disposal preference.
- EAD exercises have been run within jurisdictions, but often with a lack of industry input or consultation.
- There is a need for improved engagement between the States and industry and vice versa as there is much knowledge to be shared and benefits to be gained though collaboration. The lack of engagement between industry and the state agencies has likely resulted in a lack of knowledge of the information and processes being put in place in the various States which

translates to a lack of trust and confidence from the industry and individual farms that State agencies can handle a mass disposal or disease event.

- Many States appear to have poor processes or communication in the event of a mass disposal event.
- Industry consultation appears to be limited to specific individual farms/companies rather than the industry as a whole.
- The is a lot more focus on livestock (FMD) and poultry disposal and in many jurisdictions with less focus on pig industry.
- The lack of confidence in processes and methods has resulted from not having the experience in large EAD or disposal events for the pig industry compared to poultry industry and livestock industries.
- There is a concern there is the lack of trained experts on disposal methods e.g. composting
- Not all pig farms are licenced in Australia which limits potential pre-approval opportunities to larger farms. Victoria pig farms are also not licenced at all.
- There are limited resources and training available for EPA staff to provide preapproval for disposal methods or sites.
- Privacy and contact with EPA is a likely concern for industry due to the perceived lack of trust in the agency to find other things 'wrong' with a site. Farmers prefer to not have contact or provide information on their farms to an EPA and identify themselves if there is no requirement to do so.
- There is a lack of trained EPA staff and resources on intensive livestock not only in an emergency response but in general for decision making on licencing and approvals. A lack of understanding of an industry leads to inappropriate application of regulations and a lack of understanding in such events as a disease incursion.
- The lack of contact with small farms is a concern for State agencies regarding biosecurity and preparedness.
- All State agencies support strengthened biosecurity plans and encourage individual farms to have a mass disposal incident plan to assist in decision making and expedite the process in the event of a mass disposal or disease outbreak. It was noted that the States acknowledged that there is no promise that the plan will happen in that manner in the event of incident. There will always be uncertainty around a response to a mass disposal incident due to the myriad of factors that come into play i.e. season, pig, numbers, locality, availability/proximity of off-site facilities etc.

5.5.2 Opportunities

- Improved engagement between industry and State agencies through the development of an engagement plan and dedicated DDD representative who can represent industry. A producer from each State should also be involved to impart practical knowledge.
- Jurisdictions need to have unique species-specific approach to a mass disposal or disease outbreak to account for the differences in animal sizes, numbers, localities and management

which require different approaches for different species. What may be a viable option for one species may not be for another.

- Development of a national consistent approach to guidance materials and SOPs.
- Development of pig specific guidance materials and SOPs especially around composting, burning and end product use. Poultry industry has guidance on composting but none exists for pigs in the event of a mass disposal event.
- Further research on disposal methods targeted at pigs, e.g. grinding and composting, general mortality composting, burial spacing, biomass requirements, above ground burial and air curtain incinerators. Research should also include end-product use. There is often research on other species (i.e. cows and poultry) but little on pigs due to the lack of mass disposal incidents compared to the other industries which are plagued with more regular disease incursions i.e. FMD, anthrax, ILT and Avian Influenza. Methods that are suitable for a small animals such as chickens may be unviable for larger animals.
- National or State trained experts in disposal methods in composting design, management and monitoring.
- Development of on-site disposal plans and identification of potential off-site options for piggeries if known or have access to such information.
- Development of guidance documents for off-site receival facilities i.e. landfills, composters to provide greater confidence in receiving the products.
- Review of the burial requirements in AUSVETPLAN for pigs potentially in conjunction with research to allow for a reference to be quoted.
- The provision of a dedicated EPA officer and State DPI officers for Intensive Livestock who are trained on emergency response and work with industry.
- Facilitation of training opportunities for EPA staff for the identification of suitable on farm sites and off-site facilities specifically for pigs.

6. Depopulation

6.1 Introduction to Depopulation Methods for Pigs

The term depopulation implies bringing about the rapid removal of an entire group of pigs in one location, such as a pig farm premises. Pig farm sites naturally vary in population from less than 10 individuals to thousands of look-alike pigs. Pig farms are typically organised in 3 separate sectors:

1. A breeding farm area, where breeding females undergo mating, pregnancy, farrowing and lactation, with suckling piglets also present in the farrowing areas.
2. Nursery or weaner area, where weaned pigs are raised from 3 weeks-old to around 10-weeks-old and,
3. Growing and finishing area, where pigs are raised from 10-weeks-old to marketing. These separate sectors may be located on the same farm site (single site) or on separate sites, with weekly transport of pigs between sites. Market pigs (*ca.* 100 kg) are generally transported to dedicated processing facilities on a weekly basis. Cull breeding pigs are generally transported to dedicated processing facilities monthly. Besides naturally occurring deaths, occasional farm pigs require humane euthanasia resulting from injury or endemic illness, with disposal of the carcasses via on-site or off-site methods.

Complete depopulation may occur by removal of live pigs from the site, or by causing the death of all pigs on site, or by some proportional combination of removal and destruction. The methods for mass depopulation and disposal therefore need to consider appropriate methods for smaller (<15 kg), medium (15-30 kg) and large (>30 kg) pigs located on farms, vehicles, or processor sites.

Where pigs are to be killed, the general aim of any euthanasia procedure can be classified into two steps, firstly rendering the pig decerebrate, that is insensible or unconscious to any outside stimulus, followed by cessation of cardiac function, so that any recovery is impossible. The requirement of cardiac arrest can be met in many cases by a secondary killing or exsanguination or pithing step. These steps therefore require any depopulation euthanasia method to have the ability to induce loss of consciousness and death in a reasonable time, in compatibility with operator safety, reliability, cost, practicality, aesthetics and emotional impacts, environmental impacts, and legal requirements.

6.2 Principles of Depopulation

Prior to emergency depopulation of a pig farm, vehicle or processor site, the owner of the site, and the owner of the pigs involved, in collaboration with State and Commonwealth authorities, should have established the legal and business basis for evaluating and implementing the activity, such as the status of the site under an approved EADRA or welfare code. The scope and methods chosen for depopulation should be proportional to the scope and urgency of the EAD or related situation.

The depopulation of a processor site, a pig farm site, or a section of a site, would generally follow an information-gathering and on-site appraisal of: the size and number of animals involved; the equipment and facilities present on the site, or what could be readily transported onto the site; the number and skill sets of personnel and incident management available on the site and/or elsewhere; site security and privacy against animal and human intruders; compatibility with disposal and decontamination options.

Information would also be gathered on the presence of local feral pig populations, other local livestock and wildlife, ticks, watercourses, ground water table and other environmental factors relevant to DDD procedures.

It is likely that more than one method will be necessary for effective depopulation of any substantial pig farm site. More than one farm site may be involved. Alongside removal of live pigs, the appropriateness of the animal destruction options on-site should be assessed by the following criteria:

- Availability of the method and of relevant equipment functional for the time required
- Weather and time constraints
- Reliability of the method to induce loss of consciousness, followed by death
- Compatibility with human safety
- Aesthetics of the method and its emotional impact on personnel.

6.3 Preparation

The stages of a depopulation program are:

Team formation – team coordinator, technicians skilled at performing the procedure(s), veterinarian to assess the occurrence of death, workers and attendants to move and direct pigs, and to transport carcasses to disposal sites. Site security staff are also required.

Planning – identify the animals to be removed or killed and the choice of procedures to be conducted.

The *location(s)* for each depopulation procedure activity on or near a farm or processor site should be identified, along with the route to these locations from the area(s) where pigs may be housed or kept outdoors. The location may be within a set of yards, chutes or raceway outside the sheds, or within a shed, near to an egress point. Various types of animal restraint, such as temporary yards, panels, boards, hay bales, snares etc, will be needed. The staff responsible for site access and moving pigs should be identified. The depopulation should be conducted in a setting of privacy, enhanced by tents, tarpaulin or black plastic screens where necessary.

Various other on-site resources necessary for all depopulation methods would include animal transport carts, mechanical or manual winches, large and small mechanical loaders, power washing equipment, open and sealed transport trucks, knives, personal protective equipment, tool belts etc.
The planning of the resources for each specific method is also required - how much/how many of each resource is needed, where and when the resource can be procured, how is the resource to be maintained and stored during the depopulation incident.

There should be provision of adequate feed and water supply to any pigs held in lairage at the site(s). This lairage may be for an extended period in some sites.

The planning of DDD procedures should also provide for transport of pigs (live or dead) from the site. The method(s) chosen for depopulation need to be aligned with disposal options and not outpace methods for removal of carcasses. Removal of dead pigs from solid-walled sheds is usually a difficult and slow process, so parts of the shed(s) may need to be dismantled.

The likely requirement for local feral pigs to form part of an EAD depopulation and carcass disposal program is recognised. This will include the construction and maintenance of appropriate biosecurity measures, such as confirmation of pig-proof fences.

6.4 Depopulation Methods

This review determined ten methods likely to be effective for euthanasia during a necessary depopulation of a pig farm, vehicle and/or processor site.

It is recognised that euthanasia of pigs is particularly difficult compared to other livestock. Pigs are quick-moving, difficult to herd and difficult to handle individually. Pigs do not possess large external veins. Pigs over 15 kg have well-developed cranial bones and a relatively small brain case.

No method is guaranteed to produce death in 100 percent of pigs after an initial application. It is therefore necessary that all pigs in a depopulation event be inspected immediately post-procedure, by a veterinarian, for the occurrence of death. In some cases, a secondary killing event will need to be applied, such as an exsanguination, pithing or firearm. The preparation for depopulation therefore needs to include resources for this inspection and secondary events.

6.4.1 Anaesthetic or sedative overdose

Procedures: Injectable delivery: An overdose of an anaesthetic or sedative is delivered by injection into the blood of an individual pig (Figure 4). Water delivery: An overdose of an anaesthetic or sedative is delivered through the drinking water supply to a group of pigs. Intake of an overdose of anaesthetic or sedative quickly leads to loss of consciousness and death.

Configuration: Injection of an individual pig requires restraint and an operator skilled at injection intravenously or into a suitable body cavity alternative, e.g. intrahepatic. Installation of an anaesthetic or sedative into the drinking water of a group of pigs is performed by replacement of the drinking water with treated water, via a proportional dosage device into water lines or provision of treated water troughs.

Resources: Anaesthetic and sedative preparations are restricted to veterinary usage, but are widely available, with some designed specifically for euthanasia procedures. Australian pig farm depopulation guidelines specifically suggest the usage of sodium pentobarbitone, xylazine, azaperone and alpha-chloralose. Other available anaesthetics and sedatives widely used for pigs include acepromazine, diazepam, ketamine and telazol.

Safety: Animal restraint is required for safe injection procedures of pigs (Figure 5). Careful accounting of the handling, stocktake and storage procedures is required for any anaesthetic or sedative product.

Carcass disposal restrictions: Disposal methods for pigs containing anaesthetic drugs would not include movement for human or pet consumption.

Criteria for appropriateness: Anaesthetic or sedative overdose is considered more aesthetically pleasing than other euthanasia methods, because it depresses the central nervous system. Use of water delivered products would generally be expected to produce widespread sedation with a secondary step required in many individual pigs. The method is suitable for all ages of pigs.

Previous usage: There is extensive literature on all aspects of anaesthesia and sedation of pigs, with the lethal consequences of overdose a well-recognised feature. This euthanasia method is used widely on many pig farms and research facilities globally. It is widely approved under pig industry guidelines in Australia, Europe and North America.

Anaesthetic/sedative overdose Case Study

 # 1 – Russia. The farmer operated a large multi-site farm, with 3 breeder farms (4,000 sows) and grower-finisher sheds. The operators handled and restrained several sows and boars for euthanasia via intravenous injection of sodium pentobarbitone overdose (ear or jugular vein). Many other boars and sows were difficult to handle and were first given high doses of sedative by intramuscular injection of a xylazine/ketamine mixture, prior to intravenous injection of sodium pentobarbitone. Piglets were individually handled and injected with sodium pentobarbitone. Pigs in the connected grower-finisher sheds were also injected intramuscularly via overdoses of compounded xylazine/ketamine delivered by an injector gun. The operation consisted of 3 teams, each of 7 people, in 6-hour shifts. The operation took 2 weeks to complete.

Figure 4. Intramuscular injection of compounded sedative to groups of pigs

Figure 5. Restraint for anaesthetic injections

 # 2 – East Anglia, U.K. The farmer operated a nursery and finisher pig farm system, with 4 older-style buildings, with 500 to 1,000 pigs per shed. The site had limited staff and operator resources for depopulation and to handle the boisterous finisher pigs were 70 to 100 kg. The operator placed an overdose of sodium pentobarbitone into the drinking water supply of each shed via proportioners and troughs. Skim milk powder and sweet cordial was added to aid palatability (Figure 6). Following a deliberate period of water deprivation, consumption of the treated water was applied, with pigs becoming sedated for long periods. Secondary steps were required for euthanasia of approximately 50 % of pigs. The operation took 2 weeks to complete.

Figure 6. Water dose chemicals

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Comments – The use of sedatives and anaesthetics for pig euthanasia is considered more socially acceptable – "putting them to sleep", than most other methods. The use of injectable anaesthetic/sedatives requires trained operators. The use of water delivery anaesthetics/sedatives requires minimal handling and few resources, even for handling larger pig populations.

6.4.2 *Ingestion of poison bait*

Procedure: An overdose of an acutely poisonous substance is delivered by oral intake of a baited feed item (Figure 7). Intake of an overdose of acute poison leads to loss of consciousness and death.

Configuration: Installation of an acutely poisonous substance into the feed offered to individual or groups of pigs is achieved by provision of specifically baited feed items, such as a poison capsule embedded within an attractive matrix. Acute poisons used for this purpose are intended to induce death in a short period after consumption, e.g. within 1 hour.

Resources: Poison baits are restricted items but are widely available and used for control of pest animal populations and pig farm depopulation events. Available acute toxins designed for feed baits known to be taken by pigs, include alpha-chloralose, cyanide, para-aminopropriophenone (PAPP) sodium monofluoracetate (1080) and sodium nitrite. Other poison baits are available but not licensed for usage in Australia.

Safety: Handling of poison baits requires attention to proper protective measures, such as elbow length gloves. Careful accounting of the handling, stocktake and storage procedures is required for any poisonous product.

Carcass disposal restrictions: Disposal methods for pigs containing poison baits would not include movement for human or pet consumption.

Criteria for appropriateness: Ingestion of poison baits is considered appropriate for euthanasia of feral pigs. Similarly, some pigs in farm situations can be outdoors and/or dangerous and difficult to restrain. Ingestion of alpha-chloralose by pigs produces an initial sedative effect. Two other acute toxins listed (PAPP and sodium nitrite) target a specific deficiency in pig metabolism, namely lack of methaemoglobin repair, producing a loss of consciousness in an aesthetically pleasant manner.
Cyanide poisons cause loss of consciousness and death in pigs in a rapid manner. The appetite of ill animals in an EAD situation may be lower than that of healthy pigs. The method is not suitable for suckling pigs.

Previous usage: There is extensive literature on aspects of usage of poison baits for feral pigs. It is widely approved under pest animal control guidelines in Australia, Europe and North America. This euthanasia method has also been used widely on North American pig farms.

<u>Ingestion of poison bait Case Study</u>

 # 3 – U.K. The farmer operated an open outdoor farm with several sheds and open pasture lands with 100 roaming outdoor pigs. The pig farm was located in an agricultural region with occasional feral pigs. Many farm pigs were aggressive and difficult to handle. The pigs were herded to a central location and operators replaced feed with poison baits containing 1080. Death occurred quickly after ingestion of the bait.

Figure 7. Poison bait for pigs

 # 4 – USA. The farmer operated an established 2,000-sow medium-sized breeder farm, with modern lines of pig breeds. Commercial sodium nitrite poison baits (micro-encapsulated form) and additional chemical sodium nitrite powder was purchased and compounded. Following a deliberate period of feed and water deprivation, the operators placed an overdose of powdered sodium nitrite into the drinking water supply of each shed via proportioners and troughs. Skim milk powder was added to aid palatability. Sodium nitrite poison baits were also offered to treated pigs (Figure 8). Pigs became depressed and recumbent within 1 hour of consumption of the treated water and feed. Secondary steps were applied for euthanasia of approximately 50 % of pigs.

Figure 8. Sodium nitrite commercial bait

Comments – there are a variety of poison baits available for euthanasia of pigs, including 1080, PAPP, sodium nitrite and cyanide. The use of baits in a depopulation format means that usage is monitored in a secure area allowing for proper carcass and bait disposal. The use of poison baits requires minimal handling and few resources, even for handling larger pig populations. The time involved for larger scale bait operation of a group of pigs is usually within 2 hours after administration.

6.4.3 Firearms

Procedure: A firearm gunshot and penetrating bullet produces immediate concussion, brain damage and death (Figure 9). The frontal target for gunshot is half an inch above eye level, on the midline of the forehead and aiming toward the tail of the pig. The alternative temporal target for gunshot, particularly in larger pigs, is behind the ear, so that the bullet enters the skull from behind the ear aiming toward the opposite eye. The firearm should be 5 to 20 cm from the skull when fired.

Configuration: Euthanasia via firearms is only suitable for pigs over 30 kg. Stations may consist of chutes or corrals with removable side panels can be constructed outside of the sheds. Chutes can be constructed in an I or Y formation with a width that allows pigs to stand single file and the sides tall enough to prevent pigs jumping over. After pigs are loaded into the chute, shooting can begin with the lead pig and working back through the line. After death is confirmed, pigs are manoeuvred for disposal. Labour needs for mass euthanasia situations are estimated to be a 4-person team per station: one person to handle animals, one person to shoot, one person to handle carcasses, and one person to manage the equipment. Additional labour will be needed for moving animals to the station and moving carcasses. The number of teams on any site is limited by safety concerns.

Resources: The two main options in guns and ammunition used to effectively euthanize pigs consist of discharge of a 22-calibre rifle or a 12-gauge shotgun. Many other options exist, but these two options offer consistent efficacy. Bulleted ammunition should be round-nosed and solid to ensure penetration of the skull. The use of shotgun firearms generally lessens the chance of pass-through bullets or ricochet. Shotgun slug ammunition has more effective penetration of the skull. The euthanasia of mobile feral pigs via firearms usually requires the usage of higher calibre rifles and semi-automatic weapons.

Safety: Firearm discharge poses a high safety risk to personnel and equipment. The user of the weapon should be trained in firearm safety. Additional personnel should always remain behind the shooter. Ideally, pigs should be moved outdoors, onto soil surfaces to reduce the danger of ricochet.

Hearing and eye protection should be worn by all personnel. The temporal method presents a greater safety risk, as this shot has the potential to pass through the pig's head.

Carcass disposal restrictions: None.

Criteria for appropriateness: There is a wide literature on all aspects of the usage of firearms for euthanasia of pigs. This euthanasia method is used widely on many pig farms and pig processor sites globally. The method is widely approved under pig industry guidelines in Australia, Europe and North America. The method is widely used for depopulation of feral pigs.

<u>Firearms Case Study</u>

 # 5 – U.K. The farmer operated a contract finisher pig farm system, with groups of 500 grower-finisher pigs raised in open-plan sheds with shade roofs and the floors consisting of soil and bedding materials. Pigs were herded into groups inside the sheds with corrals formed by hay bales. Teams of trained and licensed shooters were brought to the farm and positioned on platforms above the sides of the sheds and animals killed by firearms aimed to the head. The operation required 3 teams of 7 people working 6 hours per team. Personnel, firearms and ammunition were supplied by the British army. The operation took 2 weeks to set up and then 1 week to complete.

Figure 9. Firearm pig slaughter

 # 6 – Cluj, Romania. The farmer operated an established breeder farm (800 sows), with modern lines of pig breeds. The breeder pigs and young piglets were separated, and breeder pigs taken to an outdoor corral (Figure 10). Sows and boars were restrained in a single outdoor corral chute and killed by firearms aimed to the head. Larger pigs were not suitable for frontal shots and temporal target fire was used. The operation required 3 teams of 7 people working 6 hours per team. Firearms and ammunition were supplied by the Romanian army. The operation took 1 week to set up and then 1 week to complete.

Figure 10. Outdoor corral system in Romania

Comments – depopulation by this process is reliable but is slow and dangerous. Numerous workers are required to handle the live and dead pigs. Ammunition supplies are often limited for larger depopulation incidents. The process is most reliable and suitable for large boars and sows. The method is not suitable for indoor pigs or those less than 30 kg.

6.4.4 Captive bolt guns

Procedure: The muzzle of the captive bolt gun is placed firmly against the frontal mid-line of the forehead of the pig, directed at the tail, and fired. The bolt causes concussive and physical damage to the skull and brain upon impact, leading to immediate loss of consciousness and death. The bolt may be penetrative or non-penetrative.

Configuration: For smaller pigs, depopulation stations are located so that pigs can easily be handled for workers to restrain pigs on solid surfaces, such as a table or bench at waist height to accommodate operator ergonomics. Non-penetrating captive bolt guns are effective as a single-step method for pigs weighing up to 30 kg. For larger pigs, stations may consist of chutes or corrals with removable side panels constructed outside of the sheds. Chutes can be constructed in an I or Y formation with a width that allows pigs to stand single file and the sides tall enough to prevent pigs jumping over. After pigs are loaded into the chute, bolt shooting can begin with the lead pig and working back through the line. The operator should not have to concentrate on keeping balance or bend excessively. A secondary exsanguination or pithing step is often required. After death is confirmed, pigs are manoeuvred for disposal. Labour needs for mass euthanasia situations are estimated to be a 4-person team per station: one person to handle animals, one bolt gun operator, one person to handle carcasses, and one person to manage the equipment. Additional labour will be needed for moving animals to the station and moving carcasses.

Resources: Various captive-bolt guns are available, penetrative or non-penetrative, powered by cartridge or compressed air. Captive-bolt guns are comprised of a steel bolt, with a flange and piston at one end, which is held in the barrel (Figure 11). The cartridge-powered guns can be in-line or pistol grip. The in-line style lends itself to greater comfort and less fatigue for the operator. Operators can use a 2-pouch carpenter's tool belt to hold live and spent power loads. Cartridge-powered guns will become hot and more likely to sub-fire after 15-20 minutes of continual use. It is therefore essential that these bolt guns be rotated every 15 minutes to allow for cooling. During the cooling period, the breech should be dis-assembled from the barrel to accelerate cooling and the parts inspected for damage. Replacement parts and cleaning equipment will be needed to maintain the guns throughout operation to ensure proper bolt velocity. Cartridges vary in strength and are classified according to the amount of propellant they contain, measured in grains. It is essential that the correct cartridge is used for the type of gun and the size of pig. Pneumatic bolt guns are air powered and can be used repeatedly without a cooling period. A 10 to 20 metre hose can connect the high-power compressor to the bolt gun. The equipment is heavy and less manoeuvrable than cartridge-fired guns and the animals must be restrained.

Safety: Bolt gun operators should be aware of their hand placement when restraining the pig. Hearing and eye protection should be worn by all personnel. Captive-bolt stunners should always be handled as if they are loaded. The most common cause of poor captive bolt gun efficacy and low bolt velocity is inadequate gun maintenance. Maintenance during an extended period of captive bolt gun usage is necessary to prevent misfiring and/or partial firing. In the event of a misfire and slow primer ignition, a cartridge can explode up to 30 seconds after trigger.

Carcass disposal restrictions: None.

Criteria for appropriateness: Pigs are considered the most difficult animals to stun with captive-bolt equipment. The frontal target area can be small and concave, and the brain can be protected by bony ridges and deep frontal sinuses. Operator training is needed to ensure proper bolt gun placement and equipment match to the pig size. A secondary step is often required immediately after usage to ensure rapid death. Bolt gun methods can only be performed one animal at a time and often require restraint of the pig. However, if applied properly, euthanasia by means of a captive bolt gun is considered a rapid and humane death, particularly in pigs less than 120 kg.

Previous usage: There is a wide literature on all aspects of the usage of captive bolt guns for euthanasia of pigs. This euthanasia method is used widely on many pig farms and pig processor sites globally. It is widely approved under pig industry guidelines in Australia, Europe and North America. The higher safety levels of captive bolt guns make them appropriate for usage inside enclosed spaces, such as pigs within transport vehicles.

Captive bolt Case Study

 # 7 – Alberta, Canada. The farmer operated an established farrow to finish pig farm system, with modern lines of pig breeds. The pigs were raised in older-style buildings, each housing several hundred pigs in various pens. The 300 breeder pigs, piglets and 3,000 grower-finisher pigs were destroyed on site, mostly by captive bolt guns. Pigs were moved from the sheds to a nearby location of yards and single-file races. The operation required 20 local staff over 2 weeks and 20 captive bolt guns of various types. Restraint of larger pigs was difficult to achieve in many cases. The captive bolt guns misfired after frequent usage and required regular maintenance and cleaning. Many larger finisher and breeder pigs were not able to be successfully stunned by captive bolt guns on first attempts. Second captive bolt gun usage and firearms had to be used for this group of pigs. Secondary steps consisted of pithing or exsanguination in some pigs, but their usage markedly slowed the operation.

Figure 11. Medium size captive bolt gun – in-line, penetrating, cartridge ammunition

 # 8 – Russia. The farmer operated a large farrow to finish pig farm (1,000 sows), with groups of various age pigs kept in modern buildings and some breeder pigs in adjacent open pens. Pigs were moved from the sheds to a nearby location of yards and single-file races (Figure 12). The operation required 20 local staff over 2 weeks and 20 captive bolt guns of various types. Restraint of larger pigs was difficult to achieve in many cases. The captive bolt guns misfired after frequent usage and required regular maintenance and cleaning. One operator fired a bolt through his hand. Many larger finisher and breeder pigs were not able to be successfully stunned by captive bolt guns on first attempts. Second captive bolt gun usage and firearms then had to be used for this group of pigs. Secondary steps consisted of pithing or exsanguination in some pigs, but their usage markedly slowed the operation.

Figure 12. Pigs in outdoor corrals for depopulation

Comments – depopulation by this process is slow and dangerous. Numerous workers are usually required to handle the live and dead pigs, and for maintenance of the bolt guns. Cartridge ammunition supplies are often limited for larger depopulation incidents. The process is not suitable for large boars and sows. Bolted pigs often undergo violent convulsions, making it difficult and dangerous to perform any second step. The process can be slower than using firearms, due to the extra cleaning and maintenance issues of captive bolt gun usage.

6.4.5 Electrocution

Procedure: Head-only electrocution consists of placing electrodes either side of the brain e.g. below the base of the ears on either side of the head and passing 240 V electrical current through the brain for 5 seconds. Electrocution of the brain induces stunning and immediate loss of consciousness. This method must be followed by a secondary step, such as trans-heart electrocution, or exsanguination, within 15 seconds of initial stunning. A single step or head-to-heart application is achieved by placing the front electrode on the head, level with, or in front of the brain and the rear electrode placed on the body behind the heart. The electrodes should be in full contact with the pig, prior to and during the application of electricity. Pigs stunned with electricity exhibit strong tonic and clonic movements. The method is not efficient or suitable for pigs less than 15 kg.

Configuration: Industrial electrical generating equipment is available, with electrodes in the form of tongs, wands, or saddles. The flow of electric current should be at least 1.3 amps. The efficacy of the method is affected by electrode contact with the skin, cleanliness of the electrodes, wetness of the skin, presence of hair, thickness of skin and fat layers, the thickness of the skull. Pens, walkways or chutes can be constructed to hold groups of pigs. Operators can approach individual pigs with the electrodes and apply electricity to each pig. For euthanasia with an electrocution device only, once the first head-only stun has been delivered, the electrodes must be immediately moved and placed on the chest to span the heart, inducing cardiac fibrillation and death. After pigs have been electrocuted, a secondary step applied and death confirmed, carcasses can be removed for disposal.

Resources: The appropriate power source and equipment to generate electricity of the proper amperage and voltage through electrodes is required. An isolation transformer should be used to improve safety and provide sufficient amperage. The operator should work in a dry location, wear rubber boots, and stand on a non-conductive surface. Water misters may be required to wet pigs prior to the electrocution in a dry area.

Safety: Electrocution poses a moderate risk to human safety. Proper lockout/tagout procedures must be in place to protect human safety. The pen and walkway structures should be non-metal where possible and have a perfect ground. Only the operator should be in the pen when electrocuting pigs.

Carcass disposal restrictions: None.

Criteria for appropriateness: The equipment for electrocution of pigs is an expensive specialist item. The method is not suitable for small pigs less than 15 kg, as the current passes through the skin, not the brain. The consistent presence of tonic and clonic movements under head-only electrocution means that the method is aesthetically disturbing. While proper head-only electrical stunning results in a quick loss of consciousness, it is reversible unless the second step to kill the pig is performed within 15 seconds. Single step head-to-heart electrocution requires considerable manipulation of the pigs prior to usage and this extra handling is not considered humane.

Previous usage: There is a wide literature on all aspects of the usage of electrocution devices for euthanasia of pigs. This euthanasia method is used widely on many pig farms and pig processor sites globally. It is widely approved under pig industry guidelines in Australia, Europe and North America.

Electrocution Case Study

 # 9 – Greece. The farmer operated an established farrow-to-finish pig farm system with 200 sows. The pigs were raised in older-style buildings, each housing several hundred pigs in various pens. Government teams operating a mobile slaughter unit entered the farm with industrial electrocution equipment (400-volt hog stunner, Figure 13). Grower-finisher pigs and breeding pigs (2,000 pigs) were herded into outdoor corrals and single-lane chutes. Pigs were restrained and stunned with head-only electrocution by the slaughter team. Immediate secondary killing steps included exsanguination. The operation required 2 teams of 7 people in 6 hours shifts, taking over 1 week to complete. Numerous minor accidents occurred with pig handling, restraint and removal.

Figure 13. Electrocution equipment for pigs – 400-volt stunner

 # 10 – La Union, Philippines. The farmer operated a small established farrow to finish farm, with several similar farms in the region. The farmer had few staff and hygiene levels were low. A government team operating a mobile slaughter team entered the farm with industrial electrocution equipment (330-volt hog stunner) and stunned all pigs with head-only electrocution (Figure 14). Secondary killing steps included head-to-heart electrocution or exsanguination. The operation required a team of 7 people in 6 hours shifts.

Figure 14. Mobile slaughter team results in the Philippines

Comments – depopulation of larger groups by this process is slow, unpleasant and requires trained personnel. Numerous workers are usually required to handle the live and dead pigs. The electrocuted pigs can undergo violent movements, making it difficult and dangerous to perform the necessary second step. Electrical supply equipment is often limited for larger depopulation incidents. The process is not suitable for smaller pigs or for larger boars and sows.

6.4.6 Blunt force trauma

Procedure: A major blunt force is applied by striking the frontal skull of the head at high velocity with a hard, blunt object or hammer (Figure 15). The pig suffers severe concussion and brain damage, so is immediately rendered unconscious and insensitive, with a rapid death.

Configuration: Individual pigs are handled, and the blunt trauma applied immediately by an operator. Pigs subject to this method immediately collapse, lose consciousness, and become motionless within 1 to 4 minutes. Death by cardiac arrest consistently occurs following the procedure.

Resources: Minimal equipment is required. Operator fatigue in a repetitive task is likely to occur, so team size should be appropriate for larger groups of pigs. The method should be conducted in privacy, enhanced by tents, tarpaulin or black plastic screens where necessary.

Safety: The procedure has a high level of safety.

Carcass disposal restrictions: None.

Criteria for appropriateness: Blunt force trauma is considered a quick and effective means of euthanasia, which is convenient and safe for operators. Pigs under 15 kg have relatively thin and poorly developed frontal skull bones, making them susceptible to rapid death via this method. The method may be more likely to be unpleasant for some operators to perform than other euthanasia methods.

Previous usage: There is a wide literature on all aspects of the usage of blunt force trauma for euthanasia of smaller pigs. This euthanasia method is used widely on pig farms globally. It is approved under pig industry guidelines in Australia, Europe and North America.

<u>Blunt force Case Study</u>

 # 11 – Ukraine. A company-owned breeder and nursery farm (500 sows), with various lines of breeder sows was depopulated. Breeder and nursery pigs were bred and raised from weaning to 30 kg in older style buildings. The farmer and officials gathered a team of 20 family, staff and local people but had only 2 captive bolt guns and little other equipment. Breeding pigs were stunned by captive bolt gun. All suckling piglets and nursery pigs were individually handled and euthanised by blunt force trauma. Suckling piglets were euthanised by striking the frontal cranium against a hard surface and nursery pigs (15 to 30 kg) euthanised with a hammer. Secondary steps were not required.

Figure 15. Blunt force hammer for nursery pigs

 # 12 – U.K. A family-owned breeder and nursery farm (100 sows), with various lines of breeder sows was depopulated. Breeder and nursery pigs were bred and raised from weaning to 30 kg in older style buildings. The farm was located in a semi-urban area. The farmer and officials gathered a team of 20 family, staff and local people but had only 1 captive bolt gun and little other equipment. Breeding pigs were killed by the captive bolt gun. All suckling piglets and nursery pigs were individually handled and euthanised by blunt force trauma. Suckling piglets were euthanised by striking the frontal cranium against a hard surface and nursery pigs euthanised with a special humane killer hammer. The operation took 1 week to complete.

Comments – blunt force trauma is a simple, traditional and effective method of euthanasia for pigs. The handling of the pigs is brief, and death is rapid. Pigs of any size can be killed by organising a hammer (pole-axe) of the appropriate size, but the method is not suitable for larger pigs. Operator fatigue is likely after numerous repetitive tasks.

6.4.7 Inhalant gas

Procedures:

1. Hypercapnia. Pigs are exposed to 80% to 90% atmospheric carbon dioxide (CO_2) in an enclosed container.
2. Hypoxia. Pigs are exposed to atmospheric replacement of oxygen with an inert gas, such as nitrogen or argon, in an enclosed airtight container.
3. Anaesthetic gas (e.g. chloroform or nitrous oxide) is applied directly to the pig. Loss of consciousness occurs rapidly, with effective concentrations of the inhalant gas being a function of the flow rate and container volume. When pigs are stunned due to inhalant gas applied for short periods, then a secondary killing step, e.g. exsanguination, is required. If pigs are exposed to inhalant gas for longer periods, e.g. 10 minutes, then the loss of consciousness is followed by respiratory arrest and death.

Configuration: The basic configuration for hypercapnia or hypoxia gas administration to pigs consists of an enclosed, non-slip floor container, large enough for the size of pigs to be euthanised (Figure 16). The source of carbon dioxide or nitrogen/argon gas should be high-pressure gas held in regulated cylinders or tankers, delivered to the container via an inlet valve, with an outlet valve at the top of the container. The container can therefore be filled with carbon dioxide or nitrogen/argon, while the displaced air can escape. Flow meters can be used to monitor the gas exchange rate in the container. Euthanasia by carbon dioxide inhalation can be completed by pre-charging or gradual filling of the container. The time needed to achieve effective concentration is a function of the flow rate and container volume. The fact that carbon dioxide is heavier than air, means that containers holding pigs do not need to be fully airtight at the top of the container, to induce euthanasia.

Resources: Examples of containers used for inhalant gas depopulation of pigs include plastic boxes, earthen pits, sealed trailers, shipping containers, dumpsters, or temporary corrals. A large supply of CO_2 gas for delivery into an enclosed space. Euthanasia by carbon dioxide inhalation is relatively inexpensive but requires special equipment and gas delivery to work effectively.

Safety: Carbon dioxide poses a moderate risk to human safety. Personnel should be cautious of CO_2 exposure. Risks can be mitigated by using wearable gas monitors and allowing complete ventilation of the container before entry for carcass inspection or removal. Carbon dioxide is non-flammable and non-explosive.

Carcass disposal restrictions: None.

Criteria for appropriateness: Gas inhalant euthanasia provides the advantage of euthanising multiple animals at once using a chamber, hence minimizing social distress, and is more aesthetic than some other procedures. The use of the hypercapnia method offers the ability for euthanasia of larger groups of pigs, without individual animal handling or restraint. Pigs can be quickly moved out of buildings via existing walkways, then euthanized while held in a contained environment which assists disposal. While pigs show an aversion to initial exposure to carbon dioxide, unconsciousness consistently occurs within 2 minutes of exposure to 90% CO_2. Unconsciousness and death following 90% CO_2 exposure occur significantly faster using a pre-fill method, compared to gradual-fill methods.

Previous usage: There is a wide literature on all aspects of the usage of carbon dioxide gas for euthanasia of pigs. This euthanasia method is used widely on many pig farms and pig processor sites globally. It is widely approved under pig industry guidelines in Australia, Europe and North America. Use of chloroform, nitrous oxide or hypoxia methods (nitrogen/argon) for inhalant gas euthanasia have been studied under research settings but are not widely used.

Inhalant Gas Case Study

 # 13 – North Carolina, USA. The farmer operated a large multi-site pig farm system, which moved weaner pigs from 4 breeder farms (each of 3,000 sows) to several large grower-finisher units, each with 8 to16 modern purpose-built sheds, each of 1,000 pigs. Three trailers were each loaded with groups of 50 grower-finisher pigs and the trailer air space attached to low pressure tank regulator equipment and a flow rate aimed at filling each trailer container within 5 to 10 minutes. Pigs were held in the high CO_2 atmosphere for 15 minutes then the trailer opened, and carcasses unloaded. The operation had 3 teams of technicians, each of 4 people taking 1 hour to load and unload 30 to 50 pigs per trailer. The high-pressure liquid CO_2 gas cylinders supply to the regulator flow equipment required technical expertise to ensure that lines did not freeze. The initial CO_2 gas supply was depleted after 2 days of the operation, requiring further delivery, which was not available locally. The trailer unloading procedure was difficult and slow.

Figure 16. Gas inhalation container for pigs

 # 14 – Minnesota, USA. The farmer operated a large multi-site pig farm system, which moved weaner pigs from 4 breeder farms (each of 3,000 sows) to several large grower-finisher units, each with 10 modern purpose-built sheds, each of 1,000 pigs. Three tip-up trailers were each loaded with groups of 60 grower-finisher pigs and the trailer air space attached to low pressure tank regulator equipment and a flow rate aimed at filling each trailer container within 5 to 10 minutes. Pigs were held in the high CO_2 atmosphere for 15 minutes then the trailer opened, and carcasses unloaded. Consciousness of large groups was initially assessed by cold water spray. The operation had 3 teams, each of 4 people - the tip-truck design enabled quicker unloading of 30 to 50 pigs per trailer. The high-pressure liquid CO_2 gas cylinders supply to the regulator flow equipment required technical expertise to ensure that lines did not freeze. The initial CO_2 gas supply was depleted after 4 days of the operation, requiring further delivery, which was not available locally.

Comments – this method requires specialised equipment and a high level of technical expertise. Gas supply can be limited. The movement of pigs into and out of containers can be slow, messy and dangerous work, with numerous workers required, even for a mass method. Different containers are needed for different sizes of pigs. The method is not suitable for larger breeding pigs.

6.4.8 Withdrawal of water/ventilation

Procedures: 1. Groups of pigs are deprived of access to intake of fresh water supply. 2. Groups of pigs are confined within sealed sheds and deprived of mechanical ventilation. Pigs deprived of water/ventilation develop dehydration, hyperthermia and eventual death.

Configuration:

1. Pigs deprived of water intake will perish by dehydration and salt poisoning.
2. Groups of larger pigs confined in a tightly sealed shed without mechanical ventilation (inlets, fans) will die of hyperthermia. Uniform euthanasia of pigs via ventilation shutdown method requires that the shed temperature and humidity be raised in a confined and sealed space.

Resources: The ventilation shutdown method requires that the pigs are already housed in a solid-walled, roofed building, with the ability to adequately seal access points.

Safety: The shed environment during these procedures is dangerous to humans.

Carcass disposal restrictions: Carcasses will be in a decomposed state.

Criteria for appropriateness: These methods are considered to compromise the duty of care in relation to animal welfare under Australian farming guidelines.

Previous usage: There are clinical reports on aspects of these type of events (water deprivation and ventilation shutdown), occurring on a non-intentional basis, due to faulty equipment, electrical or mechanical failure. The ventilation shutdown method is approved under pig and poultry industry guidelines in the USA, but not elsewhere.

<u>Withdrawal of ventilation and water Case Study</u>

 # 15 – Iowa, USA. The farmer operated a large multi-site pig farm system, which moved weaner pigs to several large grower-finisher units, each with 8 to16 modern purpose-built sheds, each of 1,000 pigs in an isolated and open landscape situation. The sheds had solid floors, open inlet fans and controlled ventilation units. Finisher pigs were crowded into 1 shed, fans and other outlets taped shut and the ventilation fans were turned off. External heaters were also added to raise the shed temperature. After 2 hours, the shed was opened and after a cooling period, approximately 50% of the pigs were found to have died from hyperthermia (Figure 17). The pigs were unloaded and the 50% of living pigs (mostly smaller ones) were killed by captive bolt guns. The shed was re-loaded with finisher pigs and the ventilation shutdown process repeated, this time with steam generators added to the ceiling of the shed. After 2 hours, the shed was opened and after a cooling period, approximately 90% of the pigs were found to have died from hyperthermia. The operation required teams to unload the shed and engineering technicians familiar with the sheds. The operation took 1 week to set up and then 2 weeks to complete.

Figure 17. Ventilation shutdown shed

Comments – the method requires specific shed resources, which are not commonly found outside the USA. The procedure requires engineering expertise (heat/steam humidity) and numerous people performing the dirty and dangerous job of unloading. The USA pig industry has experienced significant reputational damage from its use of this method. The method is not suitable for smaller pigs or breeding pigs.

6.4.9 Foaming

Procedure: A combination of foam concentrate, water and air produces a foam blanket, which is used to fill a confined space and immerse floor-based animals. The foam blanket covers the pigs and mechanically occludes their airways. The procedure results in hypoxia and rapid death.

Configuration: Groups of pigs are exposed to the foam blanket via commercial foam generation equipment. Groups of pigs are confined into walled spaces on a solid floor, where movement is restricted. The foam is applied via hose to a level 20 cm above the height of the confined pigs. The equipment discharges foam concentrate, e.g. 1% ethylene glycol mono-butyl ether, into a wide-gauge water hose line and this mixture forms an expansive mat of foam bubbles on exposure to air.
The foam pump hose (Figure 18) can be used to fill a pen, shed or other confined space, e.g. cart. Several operational factors are required for proper functioning of foam equipment, including foam concentrate type, water flow rate, hose type. The likely operational height limit for foam (lower than 2m), means that the method is only suitable for pigs less than 30 kg.

Resources: The foam equipment is widely available, mainly for poultry depopulation and for fire-fighting purposes.

Safety: The method enhances worker safety during any necessary depopulation of a farm building containing animals considered to be infectious to humans. Foam concentrate has a detergent and disinfectant capability.

Carcass disposal restrictions: None.

Criteria for appropriateness: The method is quick and non-invasive and does not require individual animal handling.

Previous usage: There is a wide literature on all aspects of the usage of wet foam for euthanasia of various types of poultry. This euthanasia method is widely approved under poultry industry guidelines in Australia, Europe and North America. This euthanasia method is not used widely on pig farms globally.

<u>Foaming Case Study</u>

 # 16 – Australia. The farmer operated several open-plan livestock sheds with canvas roofs and solid floors consisting of soil and bedding materials. A government team operated a range of foaming equipment units aimed into temporary pens in one of the sheds. Truck-mounted hand-held foam generating units, 18- or 38-mm diameter hose were assembled and operated at 400-700 kpa water pressure and 1-3% foam. None of the foam hose units generated foam of suitable bubble size or flow to achieve asphyxiation. Depopulation was achieved by other methods. The operation took 1 week to set up and 1 week to complete.

Figure 18. Foam equipment for open pen

 # 17 – Minnesota, USA. The farmer operated a large nursery and finisher pig farm system, groups of 1,000 pigs were raised in open-plan sheds with solid floors consisting of soil and bedding materials. Numerous nursery pigs were herded into tightly confined pen areas in one of the open-plan sheds. Other groups of pigs were also herded into farm trailers. Pens and trailers were foam filled from specialised shed foam equipment, previously used for euthanasia of poultry. Pigs were asphyxiated for 10 minutes. Consciousness of large groups was initially assessed by cold water spray. Pigs can be removed from open sheds by mechanical means.

Figure 19. Foaming floor of open-plan shed

Comments – this method requires specialised equipment and a high level of technical expertise. The method is not suitable for pigs over 30 kg, as the foam must be at least 1 metre above the head level of animals on the floor (Figure 19). The method is most suitable for open plan sheds, where carcass removal can be quickly performed.

6.4.10 Movement to slaughter

Procedure: Pigs are loaded onto standard transport vehicles and taken to a nearby processing facility capable of holding pigs and performing euthanasia procedures (Figure 20). Processing facilities in

Australia use either captive bolt guns, carbon dioxide inhalant gas or electrocution devices for stunning and euthanasia of pigs.

Configuration: Nationally agreed Standard Operating Procedures exist for the bio-secure movement of pigs during road transport. Standard transport trucks can hold 200 to 250 pigs of 100 kg. Depending on their size, processing facilities can kill 500 to 5,000 pigs per day.

Resources: Standard loading and vehicle transport facilities are widely available. There are numerous small and large domestic and export processing facilities in Australia, which can euthanise pigs in a private and purpose-built setting. The main criteria for entry to a processor facility is suitable inspection of pigs on-site and again at the processor.

Safety: The method has a higher safety outcome than on-farm euthanasia, as euthanasia of large pigs would occur in a purpose-built facility by well-trained and experienced personnel.

Carcass disposal restrictions: ASF is not considered a human pathogen, but uncooked meat is a hazard for transmission of ASF virus. Any carcass located at a processor site from an ASF outbreak, would therefore be subject to cooking of edible tissues prior to entry to the human food chain and/or pet food chain and/or disposal.

Criteria for appropriateness: There is a wide literature on all aspects of the vehicular transport to processing facilities for pigs. This depopulation method is used widely on pig farms globally. ASF is not considered an airborne disease, therefore transmission events during transport of live pigs could be minimal. Processing facilities in Australia are usually licensed for all species, so facilities that normally process other species will also be suitable. Those facilities may be less likely to suffer business disruption from their processing of pigs during an EAD response plan.

<u>Movement to slaughter Case Study</u>

 # 18 - Russia. A group of company-owned breeder and grow-out farms (8,000 sows), with various lines of breeder sows was depopulated for a notifiable EAD. The managers operated breeder, nursery and finisher farm units at different sites with modern buildings. Some sheds of younger pigs (15 to 50 kg) were depopulated by on-site euthanasia methods, but pigs of 50 to 120 kg were depopulated by transport to processor sites 100 km distant. The processor site was capable of handling 5,000 pigs per day, requiring 20 fresh transport trucks per day, for 10 days travel back and forth from the affected farm. The processor site had a large lairage system, established euthanasia equipment consisting of carbon dioxide gas inhalation gondolas, with a back-up pneumatic captive bolt equipment. The processor line was not capable of handling pigs over 120 kg.

Figure 20. Movement of pigs from farm to processing facility

 # 19 – Iowa, USA. A group of company-owned breeder and grow-out farms (12,000 sows), with various lines of breeder sows was depopulated. The managers operated breeder, nursery and finisher farm units at different sites with modern buildings. Some sheds of younger pigs (15 to 50 kg) were depopulated by on-site euthanasia methods but breeding female pigs and finisher pigs of 50 to 120 kg were depopulated by transport to processor sites 200 km distant. The large processor site was capable of handling 20,000 pigs per day, requiring 20 fresh transport trucks per day, for 7 days travel back and forth from the affected farms. The processor site had a large lairage system, established euthanasia equipment consisting of carbon dioxide gas inhalation gondolas, with back-up pneumatic captive bolt equipment. The processor line was capable of handling pigs over 120 kg, including breeding females.

Figure 21. Gas inhalation gondola in processor facility

Comments – depopulation by this method is an established farming and pig industry procedure (Figure 21). The euthanasia events are performed by trained operators with specialised equipment in a private and purpose-built setting. The method is not suitable for pigs less than 30 kg.

6.5 Confirming Insensibility and Death

Regardless of the method used, it is important to be able to recognize ineffective stunning if it occurs. It also is important to confirm the death of the pig. Insensibility should be checked shortly after the method is performed and should be monitored until death. Ineffective stunning and euthanasia can be recognized by the presence of one or more of the following signs: breathing, attempts to raise the head, vocalization, corneal or palpebral reflex (blinking), or response to a painful stimulus on the extremities. A combination of cold-water spray and individual examination of stunned pigs may be necessary in a mass depopulation situation. These tests are more difficult to evaluate following head-only electrocution stunning procedures, due to the consistent presence of tonic/clonic movements. If the pig shows any of these vital signs, a secondary step or a backup euthanasia method should be used immediately. The secondary steps consist of usage of a penetrating captive bolt or firearm, or exsanguination or pithing.

Exsanguination: Exsanguination, also known as bleeding-out, is the severance of the major blood vessels in the neck, armpit or chest that results in a rapid loss of blood flow and death. Workers performing exsanguination need to be careful of involuntary movement of pigs after the primary procedure (electrocution, captive bolt etc). There is a wide literature on all aspects of exsanguination as part of the euthanasia procedure of pigs. This method is used widely on many pig farms and pig processor sites globally. It is widely approved under pig industry guidelines in Australia, Europe and North America.

Pithing: Pithing is the physical destruction of the brain by a rod or cane. The rod is inserted through the hole in the skull made by firearm or penetrating captive bolt. The rod is then pushed into the brain to cause maximum damage, then removed. This method is also used widely on many pig farms and pig processor sites globally. It is widely approved under pig industry guidelines in Australia, Europe and North America.

6.6 Depopulation Situational Analysis

6.6.1 Previous mass depopulation events for Australian pigs

Historically, both FMD (1872) and Classical swine fever (until 1960) have been present on Australian pig farms, but were successfully eradicated prior to the widespread onset of modern indoor pig farming methods and disease eradication policy in the 1960's.

No EAD event requiring large-scale DDD procedures under AUSVETPLAN planning has yet occurred in Australian pigs. In terms of assessing relevant previous occurrences of pig farm DDD events in Australia, the intervention of Government authorities in control of emergency disease situations in Australian pig farms and large-scale accident responses are reviewed.

I. **Emergency disease incidents.** The intervention of Australian Government authorities into novel or known emergency pig farm disease incidents is recorded in at least three situations, following the diagnosis of anthrax, Menangle or Bungowannah virus.

1. ***Anthrax.*** Occasional outbreaks of anthrax (Bacillus anthracis) infection among Australian domestic pigs have been recorded. This bacterium occurs in the soil only in defined endemic regions, so it can enter the blood stream of outdoor pigs that consume this soil, or in situations where pigs are fed infected meat meal derived from anthrax-positive material. The regulatory, public health and animal suffering aspects of anthrax infection in livestock have consistently generated an emergency disease response, with involvement of authorities at a State Government level under relevant AUSVETPLAN guidelines, including movement restrictions, tracing and surveillance. In the sporadic outbreaks reported in pigs, the

emergency disease DDD response has generally consisted of partial depopulation with euthanasia of clinically affected pigs by firearms or captive bolt guns, followed by on-site disposal (usually by incineration, but also by burial or putrefaction). Remaining pigs judged as not clinically affected have been treated with penicillin and/or vaccinated for anthrax under permit, held on-farm and eventually moved to slaughter for human consumption, following on-farm and abattoir inspection.

2. ***Menangle paramyxovirus.*** An outbreak of infertility in a 2,600-sow farm in 1997 was diagnosed as due to a novel flying-fox associated paramyxovirus, known as Menangle virus. This generated an emergency disease response, with involvement of authorities at a State Government level, including movement restrictions, tracing and surveillance. In this outbreak, the emergency disease DDD and eradication response consisted of depopulation of several sections of the affected farm, with all pigs moved to slaughter for human consumption, following on-farm and abattoir inspection. The farm system continued in operation, without specific decontamination procedures.

3. ***Bungowannah pestivirus.*** An outbreak of neonatal mortality in a 6,000-sow farm in 2003 was diagnosed as due to a novel pestivirus, known as Bungowannah virus. This generated an emergency disease response, with involvement of authorities at a State Government level, including movement restrictions, tracing and surveillance. In this outbreak, the emergency disease DDD and attempted eradication response also consisted of depopulation of several sections of the affected farms. Smaller pigs and some sows were euthanised by blunt force trauma or firearms respectively and sent with the mortality carcasses to a local rendering facility. Other sows and finisher pigs were moved to slaughter for human consumption, following on-farm and abattoir inspection. The farm system continued in operation, without specific decontamination procedures.

II. **Large-scale accidents.** The trucks involved in weaner pig movements and pigs moved to processors are a sporadic source of livestock transport accidents, which may involve serious injury to groups of 200 or more pigs (Figure 22). These and on-farm large-scale accidents (e.g. flood, fire, wind damage) can require assessment and occasional implementation of DDD procedures. These incidents can involve livestock from more than one farm and owner.

Figure 22. Truck accident DDD event

The operational guidelines and procedures for emergency management of these accidents are recorded in State Government operational documents. The procedure generally consists of all pigs within an accident (e.g. fire, truck roll-over) to be gathered, and assessed for treatment or euthanasia. Depopulation of an affected vehicle or site has been conducted via movement to other premises and slaughter for human consumption and/or on-site euthanasia by firearms or captive bolt guns. Disposal of the pigs euthanised at an affected site has usually been conducted via transport to a local processing facility, rendering facility or local burial. Previous recent reports of these accidents have indicated that necessary DDD procedures (e.g. 240 injured 100-kg pigs in a truck roll-over) have been delayed, due to the lack of adequately trained and experienced staff and equipment.

6.7 Comparison of Methods – Including Stakeholder Discussions

Euthanasia of pigs is particularly difficult compared to other livestock. Pigs are quick-moving, difficult to herd and difficult to handle individually. Pigs do not possess large external veins. Pigs over 15 kg have well-developed cranial bones and a relatively small brain case. Some pigs are hostile to human handlers. These limitations therefore do not allow any depopulation method to have an ideal outcome of all pigs enjoying euthanasia via a peaceful and quick slide into death. The methods can therefore be compared for relative benefits in terms of their ability to induce loss of consciousness and death in a reasonable time, in compatibility with disease transmission concerns, operator safety, reliability, cost, practicality, and aesthetics (Table 2).

The depopulation of a pig farm site via movement to an established processing facility has clear benefits in terms of operator safety, reliability, practicality, aesthetics and emotional impacts. Pigs could be gathered at the site, inspected, placed into transport trucks and delivered (e.g. at night) to purpose-built and private processor facilities, to personnel who are experienced and trained at the task of efficient and humane euthanasia procedures for all animals delivered to the premises. The throughput from an affected farm site could be handled over several days. This method is most suitable for pigs over 30 kg, as smaller pigs are not usually amenable to the configurations at most processor facilities.

Some on-farm euthanasia methods can be performed on groups of pigs, without the need for individual animal handling, namely inhalant gas, dispensing of poison baits, foaming, or dispensing of sedative via the water supply. Recent experience with commercial supply of suckling pigs in at least 3 of the 7 Australian export abattoirs confirm that this could be used in pigs as small as 20 kg if the end-result is for condemnation, rather than commercial sale.

The benefits of these methods are the ability to keep social groups of pigs together prior to euthanasia, the ability to conduct depopulation procedures in a reasonable time frame, even on a large farm population, reduced individual animal handling or physical restraint, and the ability to simultaneously contain and humanely kill many animals while providing a means for carcass containment and disposal transport. The reduced animal handling means that the numbers of workers required for effective depopulation is reduced. Inhalant gas and foaming methods will require greater initial levels of relevant equipment and skilled personnel. Mass depopulation by deprivation of water or ventilation is not considered a suitable method.

The other suitable methods for on-farm euthanasia and depopulation usually involve handling of individual animals, namely firearms, captive bolt guns, electrocution, blunt force trauma, and anaesthetic overdose by injection. These methods are slower and require larger numbers of resources and personnel, which may be limited in a large/multiple farm situation. These tasks are repetitive and likely to lead to operator fatigue, with considerable handling and restraint stress to both pigs and workers. These time and resource constraints have been consistently noted in recent EAD depopulation exercises in Australia.

The depopulation methods may be compared for likely operator safety. Accidents involving boisterous pig handling, firearms, captive bolt guns, exsanguination and electrocution devices are well-recognised hazards in depopulation and processor throughputs. Skilled operators and maintenance are needed for proper operation of all euthanasia-related equipment and instruments over the period of an EAD response. The operation of gas inhalation, foaming or electrocution equipment is a specialised skill and liable to interruption due to mechanical or another defect.

The comparison of aesthetics for euthanasia methods is more subjective in nature. Any method that requires individual animal handling above a normal farm attendant level may be considered disturbance of the pigs. Electrocution is regarded as less aesthetic than other methods, due to induction of unnatural pig movements.

Use of anaesthetics/sedatives or gas inhalation methods may be considered more aesthetic due to the smoother loss of consciousness of treated pigs. The proper use of firearms, blunt force trauma or captive bolt guns produces a very quick loss of consciousness, but the act is not visually pleasant.

The methods needed for depopulation of a farm, vehicle or processor site within a serious EAD event are considered part of a national response for the greater good, in comparison to any depopulation involving healthy animals. The latter may take a greater emotional toll on workers and farm owners.
The comparison of EAD transmission risks regarding depopulation methods depends on the disease involved, time, and likely disposal site contamination. ASF is considered a non-airborne disease, therefore secure transport of live or dead pigs and temporary retention of live pigs on-site is not considered a major risk factor. This means that movement of pigs to an established processing facility or disposal site (e.g. rendering facility, burial site or landfill) is likely to be of low disease transmission risk. The risk of disease transmission by contamination of a farm, vehicle or processor site by blood and other tissues may be greater where invasive methods for euthanasia are used (e.g. firearms, captive bolt guns). However, other non-invasive methods (e.g. gas inhalation, electrocution) may in many cases require exsanguination as a secondary step. The extra contamination of any site during an EAD by euthanasia procedures is likely to be relatively low and is additionally addressed by decontamination procedures.

The comparison of methods for euthanasia in terms of practicality within likely time constraints, depends largely on the availability of resources, equipment and personnel, in relation to the size of farm or processor site involved. Previous EAD response incidents and exercises have commonly identified completion issues due to the lack of availability of necessary items and people. These issues arise with all the methods listed herein, such as lack of firearm ammunition, lack of carbon dioxide, lack of electrocution equipment, lack of bolt guns, lack of suitable restraint capability etc.

The on-site euthanasia methods that may be considered suitable for various age groups of pigs are listed in Table 2 and 3. All methods require an assessment of the insensibility and death of the pig following the procedure, with or without a secondary step.

Table 2 Comparison of methods of depopulation.

	Depopulation Method	Safety considerations	Key resources	Advantages	Disadvantages	Carcass Disposal restrictions	Aus Vet Plan Approved
Mass depopulation methods	**Movement to processor**	Routine safety associated with loading pigs.	Transport. Processor willing to receive infected or suspect animals.	Operation conducted by trained personnel in private and purpose-built facility. Purpose built transport options.	Only suitable for pigs capable of processor throughput, e.g. 70 to 100 kg. Processor throughput capability limits.	None	Yes-
	Foaming		Foaming equipment. Widely accessible Open pens or sheds.ie Technical experts.	Non-invasive and does not require individual animal handling. Low worker demand required. Some foams contain disinfectants, which reduces the risk of the spread of the infectious agent	Not suitable for pigs larger than 30 kg. Specialised equipment required.	None	No
	Anaesthetic/sedative overdose through drinking water		Supply of suitable pharmaceutical products. Technical experts.	Produces sedation and loss of consciousness: aesthetically pleasant. Reduced contact with individual pigs Low worker demand required.		No human or pet food consumption	Yes
	Gas Inhalation	Carbon dioxide inhalation by operators.	Appropriate containers. Large supply of gas. Technical experts.	Non-invasive and does not require individual animal handling.	Specialised equipment required. Slow throughput. High worker demand required. Supply of necessary products required. Freezing of the gas tubes have been reported, which requires a constant heating of the transporting tubes	None	Yes, but only for young pigs
	Ingestion of baits	Risk for operators handling poisonous substances.	Poison baits, e.g. 1080, PAPP, sodium nitrite.	Easy administration with feed. Low worker demand required.	Limited supply Inefficient in animals with loss of appetite. Not suitable for suckling pigs.	No human or pet food consumption	No
	Withdrawal of ventilation or Water supply	Risk for operators in altered shed conditions.	Controlled shed ventilation. Shed heaters. Sealed infrastructure Increased humidity	Non-invasive and does not require individual animal handling.	Specialised shed equipment required. Slow throughput. High worker demand required. Reputational risk to industry. Not reliable	None	No
Individual depopulation methods	**Anaesthetic/sedative overdose through parenteral route**	Risk of accidental injection of operator/assistant	Supply of suitable pharmaceutical products. Technical experts.	Produces sedation and loss of consciousness: aesthetically pleasant	Slow throughput. High worker demand required. Supply of necessary products required.	No human or pet food consumption	Yes
	Blunt force trauma	Blood and other materials creating a spillage hazard Operator fatigue	Blunt and hard object	Minimal equipment and training is required. Especially effective in pigs under 15 kg.	High worker demand Not suitable for pigs over 30 kg.	None	Yes, but only for young pigs
	Firearms	Risk of lethal accidents. Blood and other materials creating a spillage hazard	Firearms with ammunition. Permits for usage. Sufficient number of licenced operators	Effective and Reliable.	Only suitable for pigs over 30 kg. Lack of supply of necessary products required. Slow throughput. High worker demand required.	None	Yes
	Captive bolt guns	Bolt gun and ammunition accidents. Heavy equipment Operator fatigue Blood and other materials creating a spillage hazard	Bolt guns – penetrative, non-penetrative, pneumatic. Ammunition. Sufficient number of trained operators	Simple operation.	Only suitable for pigs less than 120 kg. Lack of supply of necessary products required. Slow throughput. High worker demand required. Overheating and mis/sub firing of equipment	None	Yes
	Electrocution	Electrocution accidents. Violent pig movements increase operator risk of injury	Industrial electrical generating equipment and tongs. Equipment and sufficient operators for secondary kill step Sufficient number of trained operators	Simple operation.	Not suitable for pigs under 15 Kg. Requirement for immediate secondary killing steps. Aesthetically unpleasant. Factors such as skin contact failure, wetness of the skin, hair, thickness of the skin and fat layers can reduce its effectiveness. Slow throughput. High worker demand required.	None	No

**All methods require an assessment of the insensibility and death of the pig following the procedure, with or without a secondary step.*

Table 3. Correlation of pig size and euthanasia method.

Pig Class	Movement to slaughter	Foaming	Water supply agents	Gas Inhalation	Ingestion of bait	Injection of anaesthetic	Blunt force trauma	Firearms	Captive bolt gun	Electrocution
Pigs <15kg				✓		✓	✓		✓	
Pigs 15-30kg	✓	✓	✓	✓	✓	✓	✓		✓	✓
Pigs 30-120kg	✓		✓	✓	✓	✓	✓	✓	✓	✓
Pigs >120kg	✓		✓	✓	✓	✓		✓		

**All methods require an assessment of the insensibility and death of the pig following the procedure, with or without a secondary step.*

6.8 Current Planning for Depopulation Events in an EAD

The main prevention measure for EAD incursion into Australia is proper security of national borders. Widespread and rigorous efforts by national authorities aim to ensure that infected materials do not enter Australia. The livestock industries contribute widespread and rigorous efforts to ensure that any potentially infected materials within Australia do not enter the environment or food chain of farm animals. The overall structure for an EAD response in Australia is documented in the AUSVETPLAN manuals.

The current operational manual for destruction of farm animals during an EAD in Australia is AUSVETPLAN version 3.2, 2015. This lists the depopulation of a pig farm site by usage of firearms, captive bolt guns, anaesthetic and sedative overdose, blunt force trauma, or inhalant gas (carbon dioxide), as acceptable methods for euthanasia of farm pigs. This manual suggests that pigs subjected to inhalant gas should be less than 30 kg. However, euthanasia of 100 kg pigs by carbon dioxide inhalant gas, captive bolt gun or electrocution occurs in Australia daily, at various processing facilities. The AUSVETPLAN document for African swine fever is under current development.

The current enterprise manual for the Australian pig industry during an EAD in Australia is AUSVETPLAN version 3.0, 2011. Besides the on-farm destruction methods listed above, this manual specifically lists the destruction and disposal by movement of pigs to a processing facility (slaughterhouse and/or rendering facility) as an acceptable option for certain diseases. This manual indicates that such movement would require consultations between the pig owners, Government, and processor, with a memo of understanding, covering the unloading, care, feeding and euthanasia of pigs. This manual also indicates that use of inhalant gas carbon dioxide is suitable for larger pigs, wherein they are euthanised after being placed into a large container such as a truck dumpster.

The current management plan for Australian feral pigs is the National Feral Pig Action plan, 2020. This lists firearms and ingestion of poison baits as acceptable methods for euthanasia of pigs in situations aimed at depopulation of sites.

The current Terrestrial Animal Health Code of the OIE (2019) for the killing of animals for disease control purposes lists captive bolt guns, firearms, electrocution, inhalant gas carbon dioxide or nitrogen, anaesthetic or sedative overdose as acceptable methods for euthanasia of pigs.

These current planning documents therefore contain several gaps in acknowledgement of the suitability and practicality of various depopulation measures relevant to an EAD outbreak in Australia.

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7. Disposal

7.1 Introduction

The primary purpose of disposal in an EAD outbreak is to prevent the spread of disease. It must be conducted quickly, and as soon after depopulation as possible to prevent dispersion of infectious materials. However, it must also be conducted in a manner that minimises environmental and community impacts and protects the health and safety of response personnel.

Materials from piggeries that may require disposal are potentially wide-ranging, including:

- Carcasses
- Feed
- Manure with or without bedding
- Bedding
- Washdown waters from housing, equipment and vehicles

The main emphasis of this project is on-farm methods, but it must also be recognised that in some States (particularly Victoria, Tasmania and South Australia), the preferred method of disposal is to off-site facilities such as landfills, renders or commercial composters. Nevertheless, in any significant EAD outbreak, multiple disposal options may come into play.

The principles of emergency disposal are well documented in AUSVETPLAN, both with respect to individual diseases, the particular context of piggery enterprises and other operational aspects. Indeed, AUSVETPLAN is seen as:

> *"an authoritative guideline to inform planning for the development of response documentation (e.g. plans, procedures and checklists), capability building (staff, equipment), and the actual undertaking of 3D activities during an EAD response"* (AHC37 2020).

The approved disposal options listed in AUSVETPLAN include the following:

- Burial
    - Trench burial on site
    - Commercial landfill
    - Mass burial
    - Above ground burial
- Burning
    - Open-air, including pyre, pit burning, above ground air-curtain incineration
    - Commercial incineration
- Rendering
- Composting
- Anaerobic Digestion
- Other
    - Leave *in situ*
    - Ocean disposal
    - Re-feeding
    - Alkaline hydrolysis.

In October 2019, a Depopulation, Disposal and Decontamination (DDD) Task Group (the Task Group) was established to support the work of Animal Health Committee's African swine fever (ASF) Task Force.

The purpose of the Task Group was to ensure that ASF-related information in AUSVETPLAN was up to date and relevant for both jurisdictions and industry (AHC37 2020). The Task Group comprised members of the already existing AHC emergency animal disease (EAD) 3D Task Group, plus two industry representatives.

In addition to numerous recommendations, one of the conclusions to this review the DDD Task Group report was that:

> *"All options currently described in the AUSVETPLAN Disposal Manual are feasible from a disease agent inactivation perspective. There are no disposal options recommended by the OIE or in overseas experience that are not also included in the AUSVEPLAN Disposal Manual. Therefore, the current national perspective on what methods of disposal would be used in an ASF incident are those methods that are currently approved in the AUSVETPLAN Disposal manual"* (AHC37 2020).

AUSVETPLAN is the go-to guideline for EAD planning and operational matters. The principles of disposal and the various recommended methods are covered in the AUSVETPLAN manuals. The purpose of this review is not to rehash the content of AUSVETPLAN on disposal methods in any great detail; rather, we aim to provide some insight into industry needs with respect to EAD disposal planning, the readiness and attitudes of government agencies, and identify knowledge gaps and opportunities that require further research and development.

7.2 Persistence and Transmission of EADs

Prior to discussing the different disposal methods, it is worthwhile considering the persistence of the ASF virus and other relevant EADs in the environment, as well as likely transmission pathways. These issues can have implications for the selection of the most appropriate disposal method.

7.2.1 African Swine Fever Virus

A distinctive feature of ASF is that it persists in blood and tissues for long periods after death and is not inactivated by post-mortem changes in pH, autolysis or putrefaction (Beltrán-Alcrudo et al. 2017). The virus can remain viable for many months in raw, unprocessed or frozen meat (Penrith & Vosloo 2009), but it is known to be quite sensitive to heat. Heat treatment at 60°C for 20 minutes was found to inactivate the virus in laboratory studies; for litter and manure piles the recommended time/temperature regime is exposure to 55°C for one hour or 70°C for 20 minutes (AUSVETPLAN 2020).

Windborne transmission is not likely to contribute greatly to the spread of the ASF virus between herds (Beltrán-Alcrudo et al 2017, Olesen et al 2017). Though the virus may remain viable in water, it is not expected to be present at infective levels in effluent ponds (Beltrán-Alcrudo et al 2017).
The main evidence for the transfer of ASF virus is via infected food and fomites such as vehicles, bedding, feed, equipment, clothes and footwear. Farm workers and other people or equipment used for handling pigs or pig products have all been implicated in transfer of virus.

7.2.2 Other EADs of Concern

Foot and mouth disease virus (FMDv) can remain infective in the environment for several weeks or more in soil, manure, bedding, hair, leather and dried animal secretions (AUSVETPLAN 2020). However, like ASF, FMDv is sensitive to heat - exposure to 56°C for 30 minutes is sufficient to destroy most strains. Aerosol transmission of the virus is thought to be important for ruminants, whereas for pigs the main infection pathway is likely to be via ingesting contaminated feedstuff (including swill feeding). Pigs, however, shed 1000-3000 times more virus in expired air than ruminants. FMDv can also be readily spread on fomites and by people that have been in contact with infected animals. No biological insect vector has been identified as being important in the spread of FMD.

Porcine reproductive and respiratory syndrome (PRRS) virus can survive in water for 11 days but is unlikely to survive in the environment for extended periods because it cannot withstand desiccation (Benfield et al 1999). It is also quickly inactivated by exposure to high temperatures. PRRS has been shown to move up to a kilometre from an initial outbreak (Le Potier et al. 1997), and aerosol transmission is usually associated with weather conditions of high humidity, low wind speed and low ambient temperature (Mortensen et al. 2002).

7.3 Disposal Methods

Subject to risk assessment, live slaughter of pigs for human (or even pet) consumption should be the highest priority so that the economic impact of an EAD outbreak on affected piggeries is minimised. In the case of some EADs, including Aujeszky's disease, PRRS and transmissible gastroenteritis (TGE), it is unlikely that any restriction would be placed on the movement of healthy pigs for immediate slaughter (AUSVETPLAN 2020). The same goes for a mosquito-borne disease such as Japanese encephalitis (JE). In comparison, the proposed movement restrictions for live pigs in an ASF outbreak are quite severe, even though ASF is not a zoonotic disease.

Movement restrictions of live pigs in an ASF scenario may have been proposed to limit the potential herd to herd transmission of the virus via infected carcasses, people and fomites. Perhaps for this reason also, AUSVETPLAN lists on-farm disposal (particularly deep burial) as the preferred method. Yet, some State agencies would prefer to dispose ASF-infected material to a landfill. Given the likely transmission pathways of ASF are the same whether the animals are alive or dead and off-site disposal is being considered in the plans of State agencies, consideration should also be given to disposal via slaughter and human/pet consumption. Development of biosecure transportation protocols for live ASF-affected pigs need to be developed. Additional precautionary measures can also be taken by ensuring that the meat processed in such cases is cooked prior to sale.

The summaries presented here are taken largely from the AUSVETPLAN Disposal Manual, with the addition of supplemental information from other literature and from our consultation with stakeholders.

7.3.1 Burial

7.3.1.1 On-farm trench burial

Procedure: Trench burial involves the excavation of a trench into the earth, placing of carcasses and other materials in the trench, and covering the materials (backfilling) with excavated earth. The trench can either be lined or unlined, depending on State requirements (Figure 23). The dimensions of the pit depend on the equipment used, the site and the number of pigs to be buried. A variation of this process can involve "partial composting" in an open trench with other organic matter followed by burial under soil after a specified time.

Resources: Excavators are the most efficient equipment for constructing trenches. Personnel for excavation can be supplied by contractors. Excavators facilitate separation of topsoil from subsoil and can be used to fill the trenches with carcasses and cover them with soil. The USDA estimates that an excavator with a 0.4 m^3 bucket can remove about 20 m^3 of earth per hour. Using the USDA's disposal options calculator, it would take 10 to 11 days to bury all the carcasses from a 500-sow farrow to finish piggery[2].

Other equipment, such as loaders and trucks are likely to be needed to transport carcasses from the depopulation site to disposal. The use of liners may be required in some jurisdictions and can be comprised of composite geosynthetic material or constructed compacted clay.

During the 2010/11 AI/FMD outbreak in South Korea over 3.48 million animals (151,425 cattle, 3,318,299 pigs, 8,071 goats, and 2,728 deer) were disposed of in 4,583 on-farm burial sites (Chowdhury et al. 2019). The government issued complex guidelines for construction of burial pits to minimise biosecurity and environmental risks (Figure 24), but these proved difficult to implement effectively.

Figure 23. On-farm burial trenches in Lithuania – with lining on the left. Source: Paulius Busauskas

Approvals and expert consultation: For on-site disposal of large numbers of pigs, approvals will need to be sought from environmental agencies for enactment of emergency waste disposal provisions. Consultation with environment protection agencies and other experts will also be required to identify suitable sites and for selecting the pit design and the need for any lining.

Criteria for use: Burial is an approved disposal method for most EADs, except for anthrax and transmissible spongiform encephalopathies (TSEs). Carcasses and other contaminated materials (such as bedding and manure) can be disposed of by burial. Site selection criteria are critically important but are generally well developed and accepted (Table 4), with some variation existing between jurisdictions and between State agencies.

Operational guidelines: Guidelines for burial are available in Australia and internationally. See Appendix A for a list of available guidelines

Acceptance of method: The method has wide acceptance in Australia and throughout the world for the disposal of pigs and other livestock. It is considered to be a relatively simple and cost-effective

[2] See: https://www.aphis.usda.gov/animal_health/carcass/docs/cm-calculator.xlsx

option in most cases (Table 5). Whether it is viewed as a preferred option for ASF (compared to licenced landfill, for example) varies somewhat between jurisdictions, and even between environmental agencies and agriculture departments within a given jurisdiction. The attitude of industry to it has not yet been well-established, though some have expressed reservations about the prospect of having a mass "graveyard" on the farm.

Table 4. Typical criteria by which on-farm disposal sites are selected.

Criterion	Burial	Burning	Compost
Soil type and topography (e.g. depth of soil, location of impermeable clay layer, slope etc)	***	*	**
Distance to ground and surface waters	***	*	**
Propensity for waterlogging and/or flooding	***	**	***
Proximity/access by stock, neighbours and other sensitive receptors	**	**	***
Relative seclusion from the public and passing traffic	**	***	**
Quality and condition of gates and fencing (e.g. to keep vermin and feral pigs out)	**	*	***
Access for machinery required for the disposal operation	***	***	***
Distance from sensitive areas of the farm (e.g. those still in production)	**	**	**
Consideration being given to planning controls and heritage overlays	***	*	*
Its location relative to the site used for depopulation	**	**	**

Table 5. Australian risk assessment matrix for disposal options (courtesy of AHC DDD Group).

	METHOD	TIME TO IMPLEMENT	TIME TO COMPLETE	COST	ENVIRONMENTAL RISK	DISEASE RISK	OVERALL RISK RATING
ON-FARM	Trench burial (immediate backfill)	LOW	LOW	LOW	MEDIUM	LOW	MEDIUM-LOW
	Trench burial (with partial composting)	LOW	LOW	LOW	MEDIUM	LOW	MEDIUM-LOW
	Above-ground burial*	LOW	HIGH	LOW	MEDIUM	MEDIUM	MEDIUM
	Burning (pyre)	MEDIUM	MEDIUM	HIGH	MEDIUM	LOW	MEDIUM-HIGH
	Composting	MEDIUM	MEDIUM-HIGH	MEDIUM	LOW	MEDIUM	MEDIUM
	Air curtain incineration	MEDIUM	MEDIUM	HIGH	LOW	LOW	MEDIUM-HIGH
OFF-FARM	Rendering	LOW	LOW	HIGH	LOW	MEDIUM	MEDIUM
	Landfill	LOW	LOW	MEDIUM	LOW	MEDIUM	MEDIUM-LOW
	Commercial incineration	MEDIUM	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM-HIGH
	Air curtain incineration	MEDIUM	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM-HIGH
	Burial (mass)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Burning (mass pyre)	MEDIUM	MEDIUM	HIGH	MEDIUM	MEDIUM	MEDIUM-HIGH

NOTE: This is a general guide for preparedness planning. Individual agencies should conduct their own risk assessment (for each specific situation) based on jurisdictional environmental criteria and knowledge of capacity of disposal outlets. Use AUSVETPLAN Operational Manual: Disposal procedures (Version 3.1, 2015) as a guide to decision-making. * Above-ground burial - as described by USDA

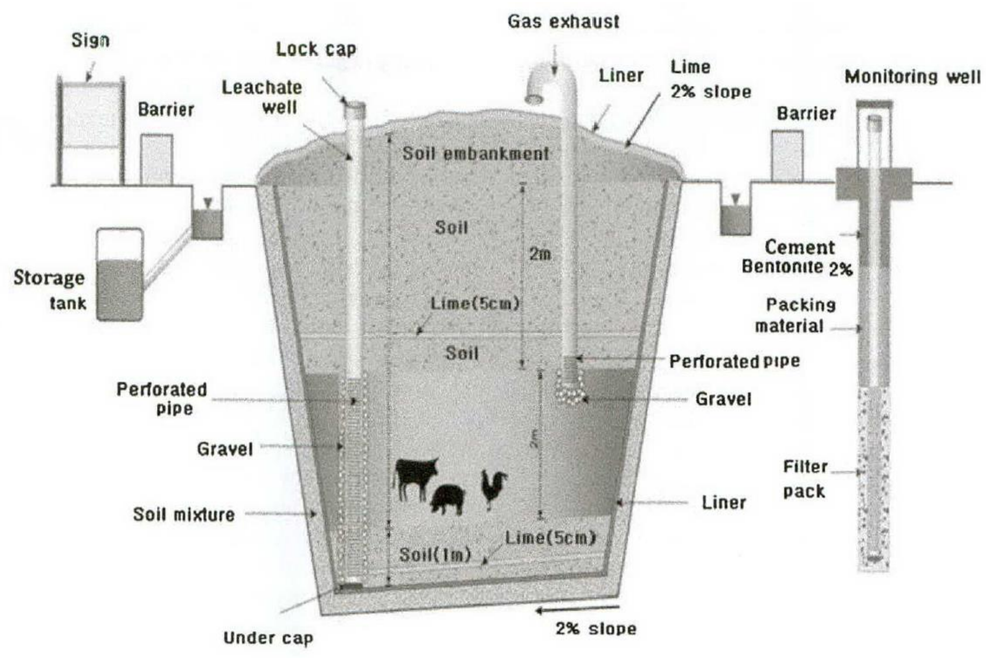

Figure 24. Burial pit design issued by the Ministry of Environment in Korea for the 2010/11 AI/FMD outbreak.

Uncertainties, risk factors and opportunities:

- Any site used for on-farm disposal, whether it is deep burial, above ground burial or composting, must be properly secured to prevent scavenging by feral pigs and carnivores. Consideration needs to be given to the installation of good fencing. Live feral pigs have been observed to take an interest in the soil surrounding carcasses (presumably because of the presence of blood and other remains), but not necessarily the carcasses themselves (Probst et al. 2017). Nevertheless, the use of any on-farm disposal method would be risky in feral-pig infested areas.
- Burial is not favoured by the USDA as an option for ASF because of concerns that it will not eliminate the virus and because of risks associated with the pollution of water tables. Studies in Lithuania have shown that DNA could be recovered from the soil and decomposed remains of buried ASF-infected feral pigs, though not the live virus (Zani et al. 2020).
- The leachate from burial pits should be collected and treated separately before disposal through effluent or wastewater treatment systems. It is now well-established that groundwater is a significant transmission pathway for pathogenic viruses of both human and animal origin (Olsen and Stone 2020). Burial trenches installed with liners will likely need a leachate collection and treatment system installed to avoid medium to long-term breaches of the membrane, or accumulation of fluids which may undermine site stability.
- Experience from the 2010/11 AI/FMD outbreak in South Korea demonstrates that it is not always possible to maintain standards for burial pits due to lack of time, equipment and laborers. As a result, many pits were inappropriately constructed, posing a potential risk of environmental pollution (Kim and Pramanik 2015).
- The installation of liners can be very costly. Composite geosynthetic liners must be durable, but they are easier to install than constructed compacted clay (CCC). CCC liners are more difficult and time-consuming to install in the field, and the quality of the installation is greatly affected by the skill of the operators involved.

- Long-term monitoring of leaching to groundwater may also be required, depending on the size of the operation and advice received from environmental regulators.
- Carcass decomposition in soil can be inhibited under certain conditions. In rare cases carcasses have been found to be "preserved" by long-term burial. For example, intact 15-year-old avian influenza-affected poultry carcasses were unearthed at a trench burial site in Virginia in the late 1990s (Malone 2005).
- The effect of lime on the decomposition of carcasses is poorly understood. It is a common misconception that lime can be used to enhance the speed of decay; for this reason, the use of lime is sometimes recommended in EAD burial operations (e.g. Kim and Pramanik 2015). However, time is no longer recommended in AUSVETPLAN, because it is believed to negatively impact carcass decomposition. Yet, lime can be an effective agent of pathogen reduction in organic waste treatment (Avery et al. 2009; Sanchez et al. 2008). Recent work by Schotsmans et al. (2014a, b) has shown that either hydrated lime or quicklime only marginally reduces decomposition rate in the short-term. After 17 months of burial, unlimed as well as the limed pigs were liquefying with the decay in the unlimed pig being slightly more advanced.
- When the carcasses were next exhumed for examination (after 42 months of burial), no differences were found between unlimed and limed carcasses. Some reduction in the rate of decomposition with the use of lime needs to be evaluated against possible improvements to pathogen reduction efficiency.
- The merits of the hybrid system, 'trench burial with partial composting', have not been fully examined. It is uncertain whether such a system would behave in any way like composting and confer an advantage to pathogen inactivation over traditional deep burial. This is because placement of the compost mix in a deep trench could impede oxygen movement into the pile; adequate supply of oxygen in compost is essential for achieving high temperatures and pathogen inactivation.

Conclusion: On-farm burial is a favoured go-to option for disposal of infected carcasses and other materials in an EAD outbreak for many jurisdictions in Australia. However, many uncertainties remain with respect to environmental and biosecurity-biosafety risk factors. The additional controls required to minimise the potential transmission of pathogens and excess nutrients to ground or surface waters, for example, may make on-farm burial less feasible than claimed.

7.3.1.2 Above-ground burial

Procedure: This is another on-farm method of disposal. There are two main variations of this method. The procedure in AUSVETPLAN involves placing the carcasses on the ground and then covering them with earth brought in from another source. The other method ("AGB-USDA" method) is a variation of trench burial in which carcasses are placed on a bed of compost material in a shallow trench and then covered with the excavated earth. Vegetation can then be grown on the mound (Figure 25). This method can be described as a hybrid between burial and composting. A perceived advantage of this system compared to on-farm burial is that it could be used in cases where deep burial is not possible.

Resources: As with deep-trench burials, excavators are used for constructing a shallow trench in the AGB-USDA method, and for haulage of materials to the disposal site (e.g. loaders and trucks). Topsoil must be carefully retained to cover the mound and to establish vegetation. If vegetation is to be established, a suitable seed mix will be required, followed possibly by fertilisation and watering. In trenchless systems, additional soil needs to be brought on to the site from elsewhere.

Approvals and expert consultation: Approvals may need to be sought from environmental agencies for enactment of emergency waste disposal provisions. Consultation with environment protection agencies and other experts will also be required to identify suitable sites and for selecting the design of the system.

Figure 25. Above ground burial. Source: Flory (2019).

Criteria for use: AGB is an approved disposal method for most EADs, except for anthrax and transmissible spongiform encephalopathies (TSEs). Carcasses and other contaminated materials (such as bedding and manure) can be disposed of with this system. Site selection criteria are still under development (USDA 2020).

Operational guidelines: A draft SOP for AGB (with shallow trenching) is available from the USA (USDA 2020).

Acceptance of method: These methods have been trialled in the USA with promising results. Research has been underway in the USA to develop the AGB-shallow trenching method, but it is largely untested in an emergency situation. AGB was used successfully in a small disease outbreak involving 111 sheep in Tunisia (Flory et al. 2017).

Uncertainties, risk factors and opportunities:

- Trenchless-AGB does not appear to provide many advantages compared to other above-ground methods like composting. It requires soil to be brought in, and unlike composting, there would be greater risk of virus survival. Furthermore, no detail is available on depth of soil cover required. Agriculture Victoria guidelines suggest a minimum of 2-m soil cover is required for deep trench burial. It would be impractical to apply the same rule of thumb to trenchless-AGB.

- The AGB-USDA system is thought to be suitable for small numbers of stock (Table 6). R&D in the USA is on-going with studies investigating pathogen reduction (using Swinepox Virus) but results from this work are not yet published (Gary Flory, pers. comm.). Previous work on rates of carcass decomposition, potential for nutrient leaching and elimination of *Clostridium perfringens* have all shown promise (Flory et al. 2017).
- Further research is needed on the AGB-USDA system to determine its advantages over traditional deep-trench burial. The Australian Animal Health Committee (AHC) DDD group has assessed the AGB-USDA system to be very time consuming (Table 5). This is in contrast to US assessments which claim that it is both cheaper and less time-consuming that deep burial.

Conclusion: The AGB-USDA system appears to be quite a promising development for on-farm carcass disposal. It should be validated for use in Australian conditions.

7.3.1.3 Commercial landfill

Procedure: Use of commercial landfill involves the use of a highly regulated pre-existing waste disposal facility, typically designed with sophisticated by-product (methane and leachate) management systems to protect the environment. Different approaches to burial in landfills are possible, depending on biosecurity considerations, the configuration of the landfill, licensing conditions and operational matters (Agriculture Victoria 2019). For example, affected materials can be disposed of in:

i) the active working face of the landfill which is backfilled at the end of the day,
ii) fresh cells can be established away from the active face, or else
iii) the material can be disposed of in trenches within existing waste cells (Figure 26).

Figure 26:Trenching within existing waste cell. This example photo was taken during a HPAI response in the USA. (Courtesy of USDA-APHIS).

Resources: Potential landfill sites are available across Australia. This includes landfills that are currently operating, and others that are unlicensed or closed but could be temporarily permitted or opened under the enactment of emergency authorizations. Carcasses would need to be transported to the landfill in a biosecure manner to limit loss of fluids and other emissions.

Approvals and expert consultation: Approvals need to be sought from environmental agencies for enactment of emergency waste disposal provisions (e.g. for sites that would not normally accept carcasses), and commercial waste levy exemptions (if applicable). Risk assessments for transportation of carcasses would also need to be conducted before movement control exemptions could be provided.

Criteria for use: Landfill is an approved disposal method for most EADs, except for anthrax and transmissible spongiform encephalopathies (TSEs). Carcasses and other contaminated materials (such as bedding and manure) can be disposed of with this system.

Operational guidelines: Guidelines for the use of landfill sites in an EAD are available in Australia (See Appendix A). A nationally approved SOP (NASOP) is available for the biosecure transportation of infected carcasses and other materials.

Acceptance of method: The method is widely accepted in Australia and overseas for disposal of pig carcasses and other infected material in an EAD outbreak. There is, however, some differences of opinion between jurisdictions, and even between environmental agencies and agriculture departments within a given jurisdiction as to whether this option is favoured or not.

Uncertainties, risk factors and opportunities:

- Questions remain about the potential of ASF and other viruses surviving deep burial, even in commercial landfills. However, these facilities are at least set up to high environmental standards, and therefore should have adequate leachate and gas control systems already installed.
- It has been listed as a moderately expensive option by the national AHC DDD group (Table 5), but costs are likely to vary widely depending on jurisdiction and the location of landfill sites with respect to piggeries.
- The method relies greatly on prior agreements being made with landfill operators. The transportation and disposal of prescribed putrescible wastes are controlled by the relevant environmental agency in each State and territory. Some jurisdictions appear to have well developed plans for landfill disposal and have begun to make the necessary prior arrangements.

Conclusion: It is understandable that disposal in landfills is an option favoured by government biosecurity agencies – it could be quite an efficient method of disposal depending on the location of the landfill with respect to affected piggeries.

7.3.1.4 Mass burial

Procedure: Mass burial is used when large numbers of animal carcasses from multiple locations are disposed of at sites that are not part of a pre-existing waste facility. It may or may not incorporate the use of sophisticated by-product management systems for leachate and gas control.

Resources: Potential mass burial sites need to be identified well in advance of an outbreak, probably on Crown land. Significant pre-EAD preparations need to be made on site assessments, facility design, engineering and construction requirements. Site construction and its operation would need to be managed by private contractors. Carcasses would need to be transported to the site in a biosecure manner to limit loss of fluids and other emissions.

Approvals and expert consultation: Site assessments and design would typically involve the engagement of geological, hydrogeological, environmental and civil engineering consultants. Proposals for a mass burial site would require any plans to be pre-approved by environmental agencies well in advance of an EAD outbreak. In the event of an outbreak, emergency waste disposal approval would to be sought for the use of the facility from the responsible environmental protection agency.

Criteria for use: Mass burial is an approved disposal method for most EADs, except for anthrax and transmissible spongiform encephalopathies (TSEs). Carcasses and other contaminated materials (such as bedding and manure) can be disposed of with this system.

Operational guidelines: Few guidelines are currently available, though we understand that some government agencies have conducted assessments of potential sites for mass disposal. For example, Agriculture Victoria has conducted initial site assessments for mass disposal at three rural research centres – Rutherglen, Horsham and Hamilton. International experience provides some guidance with respect to the technical aspects of mass burial sites (e.g. see Nutsch and Spire (2004) with respect to the UK and MOE (2010) for South Korea).

Acceptance of method: The method has wide acceptance across Australia, though we have not identified any cases where such an approach has been used for emergency mass disposal. There are examples of mass burial sites being used overseas. For example, during the 2001 outbreak of FMD in the UK, a total of seven mass burial sites were constructed to bury about 1.3 million (approximately 20% of the total 6 million) carcasses (Chowdhury at al. 2019).

Uncertainties, risk factors and opportunities:

- As with all options for burial, the potential survival of ASF and other viruses is a significant concern. These facilities could be set up with good environmental and biosecurity controls, but there is little guidance information available to suggest that these controls would in fact be implemented in an emergency.
- Little information is available on long term monitoring requirements, who will conduct this monitoring and who will pay for it.
- Mass burial has been listed as "moderate" for cost and time by the national AHC DDD group (Table 5). It is unclear how this assessment was arrived at since there could be significant delay in setting up such a site, especially one with good environmental and biosecurity controls. Costs of disposal could be reduced as a mass disposal site will not be commercial facility. However, it is unclear what cost sharing arrangements would be made between government and industry for site set-up and ongoing monitoring. From international experience, the cost of constructing suitable mass burial sites could also be substantial.

Conclusion: Mass burial is a feasible option, but it relies on significant pre-planning by government to make it a realistic possibility. The costs associated with the set-up, operation and long-term monitoring of the site are also likely to be considerable.

7.3.2 Burning

Burning or incineration ('thermal treatment') is a waste treatment process that involves the combustion of organic waste materials. By-products of the process are ash, gas and heat. Burning can be conducted in the open on-farm, or at commercial sites with fixed incinerators installed.

Procedure: Open-air burning involves the burning of carcasses outdoors, using combustible materials as a primary fuel source. This includes pyre burning and air-curtain incineration in pits or fireboxes for on-farm usage, and fixed incineration at offsite commercial and industrial facilities (e.g. furnaces, power stations and cement plants).

Pyre burning involves burning carcasses on 'pyres' constructed of solid fuels such as dry wood or coal briquettes. The carcasses are placed on top of the solid fuel, ensuring that there is sufficient airflow around them for efficient combustion (Figure 27). The pyre design and the quality of the solid fuel used will determine the efficiency of combustion. Generally, the more efficient combustion, the less smoke generated and the greater the temperature achieved.

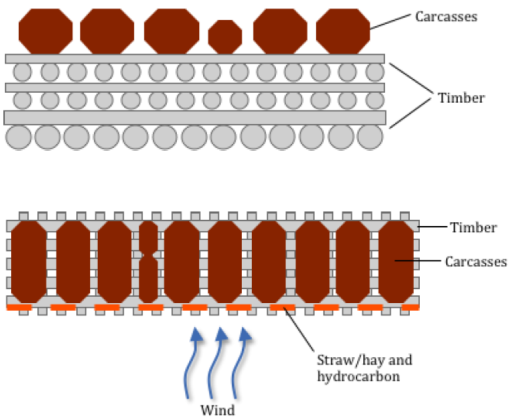

Figure 27. Construction of a pyre for carcass disposal. Source: AUSVETPLAN Disposal Manual

Air-curtain incineration involves burning materials in either a pit or a metal refractory box (firebox) using fan-forced air (Figures 28 and 29). A machine forces a mass of air across the length of the pit or box, creating a turbulent environment that greatly enhances incineration. The angle of the airflow results in a curtain of air acting as a top for the incinerator and provides oxygen, which results in a more complete burn. Unburned particles are trapped under the curtain of air in the high-temperature zone, where temperatures can reach 1000°C.

Fixed incineration plants can be specifically installed at facilities handling hazardous biological materials or can be located within industrial settings like power stations and cement plants. In addition, aluminium smelters can also be considered. They are licensed and regulated by environmental agencies, and their contained and controlled processes usually allow efficient high-temperature combustion and pollution control. However, because of their poor portability and often restricted throughput, their application to large-scale disposal can be limited. They are more suited to disease situations involving smaller volumes of material.

Figure 28. An example of a "firebox" air-curtain incineration unit. https://airburners.com.au/

Figure 29. An air-curtain incineration trench burner. https://airburners.com.au/

Resources: Pyre burning requires significant quantities of fuel (approx. 2 tonnes of wood per tonne of carcass). Coal briquettes are also useful as a supplementary fuel. Fuel gel can be used as a fuel source to initiate combustion in on-farm operations. Construction of pyres for a large outbreak may be labour intensive and require the use of chainsaws and loaders. Various companies manufacture air curtain incinerators (e.g. https://www.conceptproducts.com/ and https://airburners.com.au/, and there are Australian contractors who operate them (e.g. Organic Matter Solutions Pty Ltd). Agriculture Victoria also has one pit burner and another firebox model at its disposal. When air curtain incinerators are used for EAD disposal, carcasses and associated material must also be accompanied by wood to ensure effective incineration is achieved.

Approvals and expert consultation: Approvals need to be sought from environmental agencies for enactment of emergency waste disposal provisions.

Criteria for use: Pyre burning is an approved disposal method for all EADs, except for transmissible spongiform encephalopathies (TSEs). Air-curtain incinerators are suitable for the disposal of TSE-infected carcasses due to the high temperatures achieved. Carcasses and other contaminated materials (such as bedding and manure) can be disposed of with this system.

Operational guidelines: Few guidelines are currently available, apart from those available in AUSVETPLAN. DJPR (Agriculture Victoria) has an SOP on air curtain incineration of carcases using an above ground 'Burn Boss', but it does not cover environmental requirements. There is considerable experience with the use of these methods on small scales for the control of anthrax.

Acceptance of method: The use of pyre burning and/or air curtain incinerators is the go-to method in Australia for disposal of carcasses affected by anthrax. Air curtain incinerators are highly effective but have limited through-put capacity, and so they are only viable for small outbreaks. The use of stationary incinerators located in industrial facilities is also encouraged but is likely to only be possible for small volumes in limited circumstances. Discussions with power-station operators, for example, have identified a reluctance to consider taking EAD-affected carcasses because of the potential adverse publicity that might be associated with it; the public image of coal-fired power stations is already poor and there is little appetite to aggravate it further. The only feasible burning method for the disposal of large numbers of stock is pyre-burning, but there is great resistance to it due to the perceived negative publicity that would accompany it. Pyre-burning has been used at ASF outbreaks in Russia, but under circumstances that would not typically be replicated in Australia (e.g. they used old tyres to fuel the blaze). Some States, such as NSW and SA, are investigating the use of aluminium smelters for the emergency disposal of carcasses – it is certainly a theoretical possibility, but whether it is a realistic option for significant volumes at this stage is difficult to tell.

Uncertainties, risk factors and opportunities:

- The poor public image associated with pyre-burning during the UK FMD outbreak of 2001 is the usual reason cited for the reluctance of government agencies to consider its use on a large scale in Australia.
- It should be recognised that the problems encountered in the UK were probably the result of the sheer scale of the FMD disposal operation (> 6 million animals were slaughtered) together with the relative close proximity of farms to populated areas. The context for an Australian EAD outbreak in pigs or other medium-large size stock would be very different to the UK FMD experience. Firstly, the scale of an operation is likely to be much smaller, and secondly piggeries in Australia are typically much more isolated in comparison to their UK counterparts.
- There is little actual evidence to suggest that the public reaction to pyre burning would be any greater compared to other aspects of DDD operations, particularly mass depopulation and on-farm burial.
- Concerns have been expressed about the public health impact of smoke generated during pyre burning. Smoke from such mass burning events can be a major nuisance factor for any communities affected, but the impact is only temporary in nature. AUSVETPLAN notes that smoke should be minimised when a pyre is properly constructed. Consideration should be given to reviewing guidelines for pyre construction with the intent on minimising smoke without compromising combustion efficiency.
- Public health risk factors associated with pyre-burning should be evaluated. Areas of potential concern with respect to pyre burning include the emission of dioxins into the atmosphere (Hickman and Hughes 2002), and safe disposal of ash.
- The environmental impacts of pyre burning are likely to be more easily managed compared to deep burial.
- Pyre-burning is also reported to be relatively slow and expensive compared to other disposal methods, but this is difficult to confirm because specific guidelines for incineration of pigs do not exist.

Conclusion: Burning is a viable and effective method for on-farm disposal of carcasses and other material during an EAD outbreak. Air-curtain incinerators are highly effective for small numbers of stock. Also, greater consideration could be given to the use of pyre-burning in small outbreaks, provided that the rate of burning can keep pace with depopulation. On-farm legacy issues and environmental impacts are likely to be far less for pyre burning compared to on-farm burial.

7.3.3 Composting

Composting is the biological decomposition of organic matter under aerobic and thermophilic (>45°C) conditions. Thermophilic composting is desirable for a couple of reasons – it results in faster rates of decomposition, speeding up the composting process, and assists in the elimination of pathogens that may be present in the raw material. It is therefore frequently used in EAD outbreaks as a method for on-farm carcass disposal (particularly for poultry), with or without the accompanying manure and/or bedding materials. Although the process has appeal as a potential method of on-farm disposal, composting could also be conducted off-site – either one specifically set up for the purpose, or at licenced commercial composting sites.

Procedure: The most common type of composting system for manure and bedding materials is the turned windrow or pile (Figure 30). For EAD operations where carcasses are composted, windrows or piles are not disturbed until a majority of soft tissue has decomposed, and temperatures have been elevated for long enough to control the infectious agent. The time between set-up and the first turn depends on the size of the carcasses being composted – small animals may decompose readily within as little as 14-21 days with larger animals such as sows requiring >3 months (as a rule of thumb). Mortalities are typically fully encased in clean co-composting material (like sawdust, other bedding materials and green waste) so that leachate is absorbed, and odorous emissions are minimised (Figure 31). The depth of the casing materials (for the base, sides and cap) depends on the size of carcasses being composted. Smaller animals such as piglets typically require a minimum casing of 300-mm, larger animals 450-600 mm.

Figure 30. A typical on-farm windrow turned by loader. Source: http://www.thronefarm.co.uk/

Figure 31. Pig carcasses placed on the base layer of co-compost material. Source: Hutchinson et al. (2019).

Resources: Loaders and excavators can be used by contractors to move the carcasses to the composting site and to set up the piles. Co-composting material must be brought onto farm to supplement any bedding and manure that is already on site. As a rule of thumb, about 6 m^3 of co-composting material is required per tonne of carcass to be composted. Water can sometimes be required to irrigate the piles, especially those constructed without mortalities. Piles set up in EAD operations must be monitored to ensure that high temperatures are achieved. Then, at the designated time, the operator (government personnel, the farmer or contractors) must return with the appropriate equipment (typically a loader) to turn the pile.

Approvals and expert consultation: Approvals need to be sought from environmental agencies for enactment of emergency waste disposal provisions. Advice from these agencies and expert consultants need to be sought for selecting an appropriate site and the design and operation of the composting system. The CVO in each jurisdiction has the responsibility to declare when an EAD-derived compost product is safe for application to land or other means of disposal.

Criteria for use: Composting is suitable for all EADs except Anthrax and TSEs. Site selection criteria to minimise pollution of ground and surface waters from compost leachate are very well developed. An important consideration for piggeries, especially those in areas where there are significant populations of feral pigs and other scavengers, is the security of the site. Ideally, the site is surrounded by feral-pig proof fencing. The site must also be suitable for entry of trucks (e.g. for delivery of co-composting material) and for the operation of other machinery (e.g. for construction of piles and turning).

Operational guidelines: Few composting guidelines are currently available for mass disposal of pigs in the event of an EAD. Guidelines for mass poultry mortality composting are more readily available and could be adapted. One guideline specific for pigs from DPI NSW has been identified, and considerable information is available from the USA.

Acceptance of method: Composting is routinely practiced for the disposal of normal day to day mortalities in the intensive animal industries (including piggeries), but there is limited experience with the use of it in emergencies in Australia (except for poultry). Composting for mass pig-carcass disposal was used most recently in the USA due to market interruptions from COVID19. It's potential use in an Australian EAD outbreak is limited by attitudes associated with the lack of guidance material and science relating to pigs, the logistics of procuring the required volume of co-compost material, the lack of subject matter experts to assist such operations, and doubts about the ability of the process in destroying ASFv.

Uncertainties, risk factors and opportunities:

- We are unaware of any research that has investigated the effect of composting on the ASF virus. However, Turner et al. (1998) reported that when swine slurry was heat-treated, ASFv was reduced to below detectable levels within 90 s at 56°C. Other research has shown that composting effectively controls FMD in pig carcasses (e.g. see Guan et al. 2010), and even shows promise for degradation of TSEs in cattle mortalities (e.g. see Xu et al. 2014).
- It has been estimated that a pork carcass would take 40 hours to heat to 56°C when the temperature of the surrounding compost is 65°C (Haug 1993). Therefore, a composting process reaching 60°C would result in a >6-log reduction of all exotic pig viruses over a two-day period, even in the bone marrow of whole pig carcasses (Gale et al. 2004).
- A significant barrier to adoption of composting in an EAD response is the logistical challenge associated with procuring sufficient co-composting materials from off-site. However, piggeries operating deep litter systems may already have significant quantities of unused bedding on site that could be used for this purpose. Spent bedding/manure piles could also be used in on-farm composting systems.
- Other opportunities for accessing cheap sources of co-composting material are green waste material sourced from regional councils, mulched wood-waste (from pallets), and certain underutilised agricultural residues like bagasse, corn stover and cotton trash (depending on location).
- Concerns are often raised about the biosecurity risks associated with the need for large number of trucks entering the affected farm to deliver co-composting materials. Whether this represents a greater risk compared to truck movements involving the haulage of carcasses to landfill is debateable.

- An important consideration for EAD composting is to ensure that the entire mass of infected material is subjected to thermophilic temperatures to control pathogens. This can be challenging to demonstrate in an emergency operation – particularly when whole carcasses are part of the mix and when the pile or windrow is left undisturbed for extended periods. In practice, this risk is mitigated by encasing the "high risk" materials in clean co-composting materials, and by turning the pile after the majority of the soft tissue has decomposed. Further risk mitigation is achieved by composting for extended periods (typically many months).
- Windrows constructed with carcasses need to be carefully monitored during the first month of operation. In addition to temperature monitoring, piles must be inspected on a regular basis to ensure that cracks do not open-up on the surface due to slumping as carcasses decompose. It is perhaps for this reason that the national AHC DDD Group assesses composting as taking a "medium-high" time to complete (Table 5).
- CVO units are very risk adverse and there is concern that, even though time-temperature criteria may have been achieved in a windrow, it would not be declared safe until there are no signs of carcass left.
- Concerns about feral pigs and other scavenging animals are justified. Sufficient casing material around the composting mass should be sufficient to prevent scavenging. But this may not be an adequate measure of control in many areas with feral pig populations. Piggeries in these areas may wish to consider the installation of pig-proof fencing as a means of preparing for ASF, regardless of whether composting is to be used or not. In any case, improved fencing may also need to be installed around any other on-farm disposal sites involving other methods (e.g. AGB and deep burial).
- There are many opportunities that could be explored with respect to EAD composting in Australia. For example, consultation was conducted with the membership of the Australian Organics Recycling Association (AORA) to establish their level of interest and capacity to assist the pig industry in the event of an ASF outbreak. The response has been encouraging – they could assist with the procurement of co-composting material, provide advice and supervision of on-farm composting operations, and possibly provide equipment (e.g. heavy equipment and temperature monitoring probes). A couple of companies (Water Hold Pty Ltd and BioGrow Recycling) contacted us expressing an interest in managing multiple on-farm composting sites since they are mobile operations and already service composting sites associated with the intensive animal industries.
- A combination of on-farm and off-farm composting operations could be considered. One possibility that could be explored is the completion of the first stage of composting on-farm, followed by biosecure transportation of the compost to a commercial composting site for completion. Nutrient rich EAD-derived compost would be a valuable feedstock for the commercial composting site. The additional controls associated with the commercial composting site would result in a safer, more marketable compost product.
- Developments in the USA with the use of composting for mass disposal of pigs have been promising. Two centralised sites in Minnesota were used to compost ground-up (macerated) pig carcasses from the COVID-19 market disruptions (Gary Flory, Virginia Department of Environmental Quality, pers. comm.). Large-scale industrial grinding equipment were used

(Figure 32). This results in dramatic improvements in the efficiency of composting – it could potentially reduce effective pasteurisation[3] time down from 2-4 months to 1-2 months.

- Based on our calculations, grinding carcasses for compost mixes has the potential to reduce the volume of co-compost material required down from about 6 m^3 per tonne of carcass to about 3 or 4 m^3.
- Grinding carcasses improves the uniformity of a compost mix leading to improved pathogen reduction efficiency. This is achieved with the improved process control that results from the opportunity to increase the frequency and efficiency of turning. For example, on-farm windrow turners (Figure 33) greatly improve turning efficiency and shorten composting times but they can only be used in relatively homogenous mixes (i.e. not in windrows containing whole carcasses). They are widely available throughout Australia, are transportable and can be operated by a tractor with a PTO-drive.
- One concern about the use of grinding for preparing carcass composting mixes is the potential dispersion of virus particles from the back end of the grinder. This is currently being evaluated in trials by the USDA and results should be available by the end of 2020 (Dr Lori Miller, USDA-APHIS).

Figure 32. Carcass and grinding composting trials conducted in North Carolina. Source: Flory et al. (2019)

Conclusion: Composting is a viable option for disposal of ASF-affected materials either on-farm or off-farm. There are significant logistical challenges associated with it, but with adequate pre-planning it could play a more prominent role in EAD response than is currently envisaged. The lack of guidance and science around pig composting in a mass disposal incident likely contributes to the reluctance by State agencies to consider composting as a potential viable option.

[3] In the context of composting, pasteurisation means the point at which pathogen reduction criteria have been met. The composting process may not be fully completed, but the product is safe to turn, move or process further at another site.

Figure 33. An on-farm compost windrow turner.

7.3.4 Rendering

Procedure (taken from ARA 2014): Rendering is the process of separating the lipids or fats from meat tissue and water under the influence of heat and sometimes pressure. In 'wet rendering', tissue is ground to a small particle size of about 12 mm and preheated at around 95°C for between 5 and 60 minutes depending on the system. The heated slurry is then pressed or centrifugally separated into liquid and solid phases. The liquid which consists of lipids and water is then centrifugally separated into separate streams. The wet solids are dried then milled to a free-flowing meal. In 'dry rendering', the tissue is ground to about 30-40mm then heated in a jacketed container, mechanical agitation is provided, and the water evaporated either at atmospheric or increased pressure. The fat and solids are then separated over a screen. The fat is refined to remove any fine particles of solids remaining. The solids are pressed to remove excess fat then milled to a free-flowing meal.

Resources: Information obtained from the Australian Renderers Association indicated that there are 82 accredited rendering plants in the country. Sixty-eight plants are integrated with an abattoir and are only equipped to render on site material. In most cases they are federally registered export facilities prohibited from bringing in outside material. Fourteen plants render products sourced from supermarket chains, boning rooms and independent butchers.

Approvals and expert consultation: Rendering plants already have the appropriate licence to operate. Permits for the movement of pigs from either control or restricted areas to rendering facilities would be required.

Criteria for use: It is approved for all EADs except TSEs.

Operational guidelines: Rendering plants have their own operational guidelines for processing pig carcasses.

Acceptance of method: The method has wide acceptance by biosecurity agencies in Australia and world-wide, though it is generally considered to be one of the more expensive options (Table 5). However, the method generally does not have the support of the Australian Renderers Association.

Uncertainties, risk factors and opportunities:

- The official position of the Australian Renderers Association (ARA) is that renderers in general will not process animals from a disease eradication program. Rendering plants in Australia are generally not equipped to handle whole carcases. Most plants are setup to handle the inedible parts of animals slaughtered for human consumption.
- There are some exceptions to ARA's general position on these matters. For example, CSF (Camilleri Stockfeeds) Proteins in Laverton North (Vic) has been working with the nearby Diamond Valley Pork abattoir to possibly take non-diseased pig carcasses that might be associated with market disruptions (e.g. COVID and possibly ASF). Pork is introduced into CSF's mixed red meat line in combination with other meats because it is difficult to process on its own. Deliveries would therefore need to be scheduled to take this into account.
- As of 2015/16, 50% of mammalian protein meals and 73% of animal fats were exported. Access to export markets is dependent on trade rules surrounding the biosecurity of rendering processes. Renderers are therefore very reluctant to risk processing any animal product that could perceivably put export markets at risk. Dead stock (whether diseased or not) are prohibited in feed ingredients for food producing animals and pet food in most export markets.
- Consultations undertaken as part of this review have identified some engagement between biosecurity agencies and the rendering industry, but it remains to be seen whether they can overcome the barriers to wider use of rendering in an EAD outbreak. Any progress made on this front depends on prior arrangements being made between EAD responders, abattoirs, and individual rendering facilities. For example, we are aware of discussions held between SunPork and AJ Bush and Sons about the possibility of the renderer taking an additional 500 tonnes per week via the Swickers processing facility. AJ Bush is also a manufacturer of biosecure transport vehicles. There are many caveats involved in such discussions since 90% of their mixed red meat meal is exported.
- Piggeries, abattoirs and rendering plants have such close business relationships that the declaration of a piggery as an infected premise could result in the same for the abattoir or rendering plant, or they could be declared dangerous contact processing facilities, for example. In this case it may make sense for processing facilities to assist the response and recoup what would otherwise be a break in production. Hypothetical circumstances such as these are difficult to prepare for.

Conclusion: Rendering is an attractive option, but the main issues associated with it resolve around the real or perceived risk to markets for rendered products, and capacity issues. These are complexities that will limit the use if rendering to particular circumstances, and likely limited to small numbers of stock.

7.3.5 Anaerobic Digestion

Procedure: Anaerobic digestion (AD) is a process by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste and/or to produce fuels. AD facilities convert effluent from a range of different organic waste streams into biogas (methane), carbon dioxide, and a low-solids content sludge. The biogas that is generated can be used for heating and/or electricity generation. High-technology

AD systems can operate at either mesophilic (30-40°C) or thermophilic (50-55°C) temperature ranges. The most common AD systems in Australia are covered or uncovered ponds (operating at ambient temperature) (Figure 34), with more advanced facilities involving a series of digester tanks operating at mesophilic temperatures (Figure 35).

Figure 34: Anaerobic effluent ponds. Source Pork CRC

Figure 35. Anaerobic digester tanks

Resources: The vast majority of piggeries have an anaerobic pond system to treat manure slurries and washdown water. Three Australian piggeries have an AD digester-tank system. The construction of AD plants in Australia is likely to increase in the coming years – for processing animal industry wastes, other food processing and industrial waste streams and those from urban areas (such as food waste and biosolids).

Approvals and expert consultation: AD systems are relatively complex and time-consuming to establish. Their use in an EAD outbreak would therefore be confined to facilities already in operation. However, emergency approvals many need to be sought for any waste treatment facility taking waste material outside their usual licence conditions.

Criteria for use: AD systems could potentially be used in all EAD outbreaks except those involving anthrax and TSEs. The main operational criteria to consider are maximum loading rates and the presence of a pasteurisation step (usually 60°C for 1 hour) as part of the process. AD systems operating in the ambient-mesophilic temperature range (<40°C), must include a pasteurisation step for effective pathogen control. The pasteurisation step can be included prior to the AD process or after it has been completed (Jiang et al. 2020).

Operational guidelines: Each facility will have its own operational guidelines. No specific guidelines exist for the use of AD systems in an EAD outbreak.

Acceptance of method: Although AD is an approved disposal method in AUSVETPLAN, there is little practical experience of its use in emergencies in Australia or overseas.

Uncertainties, risk factors and opportunities:

- The biosecurity credentials of ambient-mesophilic AD systems are questionable. Multiple studies suggest that some form of thermophilic pre- or post-pasteurisation treatment of the waste stream is necessary for effective pathogen reduction (Jiang et al. 2020). We are unaware of any piggeries in Australia operating an AD system encompassing a pasteurisation step. There are, in fact, very few Australian AD systems at all that encompass a pasteurisation step.

- If carcasses were to be used in an AD system, they would have to be macerated first, adding to the cost of disposal.
- Before entry into an AD system, macerated carcasses could be heat treated to control pathogens. Adding heat-treated carcasses to an effluent pond can result in thermal channelling which reduces hydraulic retention times.[4] Thermal channelling is avoided in tank systems with mechanical agitation.
- AD systems have a notorious reputation for being "fussy eaters". For this reason, new waste streams entering the system are typically blended with a variety of other waste streams to prevent system "shock". This can make operators reluctant to change their recipe by adding too much too quickly.
- AD systems are typically used for treating low-solids waste streams (<10% solids content)[5]. This limits the potential loading rate of solid material like carcasses. Another factor limiting loading rate is the inhibitory effect of ammonia on the growth of anaerobic bacteria. Care needs to be taken to ensure that loading rates of protein-rich materials like carcasses do not exceed the capacity of digesters to handle increased ammonia generation. AUSVETPLAN estimates that the maximum loading rate for AD systems is about 3.6 kg of meat per cubic metre of digester capacity per day. It is estimated that 2000mg/L of N per ML of digester would be the limiting factor.
- Anaerobic effluent pond systems may be adversely affected by chemicals used in the farm decontamination process.

Conclusion: AD systems are unlikely to play much of a role in emergency disease response in Australia. Doubts exist around the efficacy of existing systems in Australia with respect to pathogen reduction, and the capacity of digesters to take protein-rich wastes like carcasses is likely to be severely limited.

7.3.6 Other Methods

Four other disposal methods are listed in AUSVETPLAN. These have not been reviewed in any detail in this report since they are highly unlikely to play any role in an EAD outbreak. These are:

- Leave *in situ*. Not an option for domestic pigs. Kill and leave may be unavoidable if an outbreak occurred in feral pigs, but this is outside the scope of this review.
- Ocean disposal. Probably more likely for disposal of marine animals. A comprehensive discussion with experts in shipping and maritime issues would be required to assess the practical feasibility of disposal at sea. Carcasses may need pre-treatment (e.g. grinding) to prevent floating, or else containers may need to be used. Disposal of animal carcasses too close to land could attract scavengers. Not realistic at this point for the pig industry.
- Re-feeding would involve the feeding of pigs to other animals – for example like those in zoo collections.

[4] This essentially means that the heated substrate exits the pond too quickly; it is not retained long enough to undergo stabilisation.
[5] High-solids AD systems with 15-35% solids are very rare.

- In alkaline hydrolysis, a body is placed in a pressure vessel and filled with a mixture of water and potassium hydroxide. It is then heated to around 160°C at an elevated pressure. Under these conditions a body breaks down over about 4 to 6 hours into a liquid slurry. The method is highly effective but limited by availability and scale. One company in Australia is known to operate an alkaline hydrolysis unit at a crematorium.

Another possible option worth further research is the disposal of carcasses in mine-tailings dams. Mine tailings dams are already classified as contaminated sites as they typically contain high concentrations of toxic metals, caustic compounds or acids used in mineral processing. Under such conditions, carcasses would be expected to breakdown quickly. We are not sure whether this option has been explored in any real detail. However, the long-term structural integrity of mine-tailings dams is of significant concern, and mining companies would not welcome additional public scrutiny that would potentially come with mass carcass disposal. At the very least, mining companies would need legal protection to ensure that the use of their tailings dams for emergency carcass disposal would not exacerbate an already considerable regulatory burden associated with their normal operating conditions.

Table 6. Pros and cons of different disposal options. Adapted from Agriculture Victoria.

Options	Pros	Cons
On-farm		
Trench burial (immediate backfill)	♦ Effective method for ASF ♦ Easy to access machinery/contractors ♦ Could be relatively inexpensive ♦ Materials contained on-farm	♦ Perceived and potential risks to groundwater ♦ Option may be limiting if involves large numbers of animals and minimal land space ♦ Could be expensive if trench liner is required ♦ Long-term legacy for farm uncertain
Pyre burning	♦ Effective method for ASF ♦ Materials may be contained on-farm ♦ Short-term environmental risks ♦ Can be used where high water tables are an issue ♦ End product spread on farm or shallow buried as a soil conditioner/fertiliser	♦ Perceived risks of smoke for public health (including dioxins) ♦ Requires large volumes of timber ♦ Lack of guidance materials for pigs
Air Curtain Incineration	♦ Effective method for ASF (sterilisation) ♦ Can be used where high-water tables are an issue ♦ Only short-term monitoring required (air quality) ♦ Ashes pose negligible risk to environment ♦ Agriculture Victoria has two units ♦ Commercial contractors available with equipment	♦ Limited capacity – (approx. 350 pigs equivalent per day using a 10 hour burn day – Pit burner) and (approx. 50 pigs per day using the above ground burner) ♦ Requires excavator and/or front-end loader to load materials ♦ Large volume of timber required to fuel the incinerators ♦ Likely to be moderate to highly expensive
Composting	♦ Effective method for ASF virus	♦ Requires large volumes of carbon material

	♦ Infective materials contained on farm ♦ Can also utilise carbon materials from the farm (bedding and spent litter) ♦ Opportunities for process improvement through carcass grinding (R&D) ♦ Reuse opportunities for end product as a soil conditioner/fertiliser	♦ Requires active monitoring (pest control, cover material, turning) ♦ Large animals take long time to be consumed (>4 months) ♦ Limited agency experience in this setting ♦ Lack of guidance materials available for pigs
Above-ground burial	♦ Effective method for ASF virus ♦ Infective materials contained on farm ♦ Can also utilise carbon materials from the farm (bedding and spent litter) ♦ Can be used where high water tables are an issue?	♦ Requires moderate volumes of carbon material ♦ Requires active monitoring (pest control, cover material) ♦ Large animals take long time to be consumed (>6 months) ♦ Relatively labour intensive (over long term) ♦ Limited agency experience in this setting ♦ Lack of guidance materials for pigs
Off-farm		
Landfill	♦ Effective method for ASF ♦ Can be licensed to receive waste (putrescible waste) or provided an emergency authorization to accept wastes to an unlicensed or closed facility ♦ Good level of security ♦ Good long-term containment ♦ Leachate collection systems ♦ Large available airspace ♦ Previous use in natural disasters (flood, bushfire) ♦ Machinery/staff/expertise available on site if an operating facility ♦ Waste levy can be waived	♦ Requires biosecure transportation and decontamination facilities ♦ Potential for negative publicity (leaking & transport route) ♦ Complication with maintaining normal waste operations ♦ Likely to be moderate-highly expensive (paying for long-term containment) ♦ May not be suitable facility in a reasonable transport range
Mass Burial (public land)	♦ Effective method for ASF ♦ Large capacity for disposing of materials ♦ Ability to control and manage own site	♦ Requires biosecure transportation ♦ Requires decontamination off property ♦ Requires moderate/high level of environmental controls ♦ Use of land will need to be negotiated ♦ Requires detailed site investigation (environmental engineer, EPA, other agencies) ♦ Requires significant resources to operate and manage over the long term
Mass Burial (private land)	♦ Effective method for ASF ♦ Large capacity for disposing of materials (provided suitable site) ♦ Ability to co-share long term containment responsibilities	♦ Requires biosecure transportation ♦ Requires decontamination off property ♦ Requires moderate/high level of environmental controls

		♦ Use of land will need to be negotiated with private landholder ♦ Requires detailed site investigation (environmental engineer, EPA, other agencies) ♦ Requires significant resources to operate and manage over the long term ♦ Likely to be very expensive to pay for a private land solution
Rendering	♦ Effective method for ASF ♦ Good environmental outcome (potentially being re-constituted) ♦ Rendering facilities might be looking for a solution to keep their facilities open in the face of a disease outbreak	♦ Requires biosecure transportation ♦ Very limited capacity in most locations ♦ Limited by rate of processing at plants and quality of material ♦ Limited capacity to breakdown pig carcasses ♦ Disruption to normal business ♦ Implications on export licensing ♦ Potentially costly ♦ End-product may still need to be disposed of by another route (burial) ♦ Complex decontamination of rendering plant required at end ♦ Limited agency experience in this setting
Incineration (Fixed facility)	♦ Effective method for ASF ♦ Facilities have good biosecurity ♦ No on-going monitoring required	♦ Very limited capacity (throughput and size of incinerator entry door) ♦ Likely suitable for small animals only ♦ Requires biosecure transportation ♦ Likely to be very expensive ♦ Limited agency experience in this setting ♦ Disruption to normal business operation
Composting (commercial facility)	♦ Effective method for ASF ♦ Materials removed from properties ♦ Good environmental outcome ♦ Commercial operator takes responsibility for monitoring ♦ Potential sale of end-product (rather than disposal/stockpiling) ♦ Opportunities for process improvement through carcass grinding (R&D)	♦ Requires biosecure transportation ♦ Likely to be expensive. Fees could be potentially negotiated by State government ♦ Ability to sell/use end- product may be limited

7.4 Determining the Feasibility of Disposal Methods

There are many factors to consider in determining the feasibility of different disposal options, and the mix of methods employed on any one property or in any EAD event could vary greatly. Different disposal methods may also be considered for different materials (e.g. small carcasses vs large carcasses, and carcasses vs manure piles vs size of operation), depending on the risk assessment conducted at the beginning of the operation.

To determine the feasibility of a disposal method this review has taken an industry-focused approach acknowledging that this is unlikely to fully align with the perspective of government. It reflects our understanding of industry's perspectives in the light of practical EAD experiences (local and international) and current scientific developments.

7.4.1 Stage 1 – short-listing the disposal methods

A first pass was conducted over each of the main disposal options covered in this report to determine a short-list for further evaluation. The factors considered in this first exercise were:

1. The scale of the outbreak (i.e. very small to very large) and the context (e.g. whether it occurs in areas infested with feral pigs or not).
2. Timing of disposal with respect to the method of depopulation. Some disposal methods are time consuming whilst others are less so. The rate of depopulation must match the rate at which carcasses can be safely disposed of. We have assumed a depopulation rate of 40-60 tonnes of carcass per day (based on use of captive bolts and firearms).
3. Logistical issues – how complex the method is to organise and complete given the pressures that come with an emergency response. Many disposal methods are assessed as "feasible" in AUSVETPLAN, but they are not necessarily likely to ever be used.

Time to complete the disposal process ("Process Time" in Table 7) was rated for each option in relative terms. Process Time was determined by consulting the USDA's Carcass Management Calculator which compares the relative time requirements of various carcass disposal methods. Using this as a guide, composting was found to be three times more time-consuming than landfill, and on-farm trench burial twelve times, for example (Table 7). In this metric, Process Time means the time it takes to transport carcasses offsite (e.g. to landfill, rendering etc), or the time it takes to cover exposed carcasses with soil or compost. It does not include the time it takes to completely breakdown a carcass after set-up (this is considered in Stage 2 of the assessment).

Similarly, the logistic of each disposal method was rated on a qualitative scale of one to ten, with one being the easiest to arrange and ten the most difficult. Landfill was considered the easiest disposal method to arrange (with a score of one). Rendering was considered the most complex because of the complex negotiations that would normally need to be conducted to make it a realistic possibility. Other disposal methods vary in logistical complexity depending on circumstances. For example, an on-farm composting operation using existing farm equipment is much less complex than setting up a centralised site with specialised equipment supplied by contractors (Table 7).

Table 7. Short-listing of disposal options – initial considerations

	Disposal Method	Process Time*	Logistics*	Location	Context
Most feasible disposal methods	Landfill	1	1	Off-site only	• Convenient and fast provided that a facility is within reasonable distance. • Suitable for all scales of outbreaks. • Rate of depopulation must be matched with availability of biosecure transport vehicles.
	Composting	3	Situation dependent 2-7	Situation dependent - on-farm or off-site	• On-farm disposal in small to medium-scale outbreaks in areas without feral pigs. • Relatively complex logistics – sourcing sufficient co-composting material, machinery and personnel with experience in composting. • Method is quick to set up – should keep pace with depopulation. • On-farm: manure and bedding, pigs <10 kg in size or for small outbreaks with larger animals that can be managed with existing farm equipment. • Medium to large outbreaks served best with an off-site centralised composting site with the right equipment (e.g. loaders, grinders and compost turners). • Competitive with landfilling when used in larger scale outbreaks, but it is still more logistically challenging than landfill.
	Above ground burial	6	3	On-farm most likely	• Much quicker to set-up than trench burial and less restrictions on site requirements. • Suitable for on-farm disposal in small-scale outbreaks in areas without feral pigs.
	Trench burial	12	2	On-farm most likely	• On-farm disposal in small-scale outbreaks in areas without feral pigs. • Strict site selection criteria apply. • Relatively time consuming to set up. • May have difficulty keeping up with depopulation.

					• Off-site mass burial is an option but expensive and logistically challenging to set up at short notice with appropriate gas and leachate control systems.
	Pyre burning	NA	5	On-farm most likely	• Small outbreaks. • Time consuming to set up pyres and large animals can take many hours to fully burn (20-24 hrs for bovine). • Requires 24-hr supervision and the availability of firewood at a reasonable price. • Best reserved for large scale anthrax and TSE outbreaks.
Least feasible disposal methods	Rendering	NA	10	Off-site only	• Only suitable in specific circumstances for small numbers of animals. • Option for companies with integrated piggery-abattoir facilities and where the rendering facility has been declared a DCP/DCPF.
	Anaerobic digestion	NA	8	On-farm or off-site	• On-farm options are limited to a few piggeries with anaerobic digester reactors (tank systems) or else the use of effluent ponds. • Never likely to be an option for all but small quantities of carcass in limited circumstances.
	Air curtain incineration	NA	5	On-farm most likely	• Expensive and limited by the availability of mobile incinerators. • Not likely for all but the smallest outbreaks, especially those involving anthrax or TSEs.

**In relation to landfill. NA - not enough information available or highly situation dependent*

This analysis has shown that landfill is almost always a feasible option. The feasibility of other disposal methods depends on context (on-farm, off-farm, scale etc). For this reason, we have considered different scenarios for further assessment in Stage 2.

The 8 short-listed disposal scenarios are as follows:

- Scenario 1: Landfill – viable in almost all cases assuming that a suitable facility is within reasonable distance.
- Scenario 2: Composting – there are three configurations that are possible depending on context:
    - 2a: On-farm operations in feral pig-free areas; full sized pigs in small outbreaks using farm machinery.

- 2b: On-farm operations in feral pig-free areas; Small pigs (<10 kg) as well as manure and bedding in most scales of outbreak; use of farm machinery in small outbreaks or contractors in med-large outbreaks.
- 2c: Off-site operations on government land using contractors with specialised composting equipment including grinders on a medium to large scale.

- Scenario 3: Above ground burial – on-farm; small-scale outbreaks in feral pig-free areas.
- Scenario 4: Trench burial – on-farm; small-scale outbreaks in feral pig-free areas.
- Scenario 5: Pyre-burning – on-farm; small outbreaks in areas where there is good supply of wood as fuel for burning at a reasonable cost.

7.4.2 Stage 2 – Comparison with landfill as the benchmark disposal method

Disposal Scenarios 2 to 5 were then assessed relative to landfill (Scenario 1), as it is clearly the benchmark disposal method.

For this analysis we used 6 criteria, each weighted in relative importance after consultation with industry:

1. ***Speed of resolution*** – i.e. the time taken from the completion of the disposal activities until the farm is cleared for restocking. This issue was consistently rated highest in importance by industry (***weighted on average at around 46%).*** Key questions here for disposal are:
   i. is the disposal operation likely to delay approvals for return to business as usual?
   ii. what information/data would be required by the CVO unit before a disposal site is considered safe?
2. ***Cost.*** Whilst cost is an important consideration (***weighted on average at around 18%***), it is not as important to industry as speed of resolution. Cost-sharing arrangements with government are of significant assistance here. Industry may tolerate higher upfront costs for a better overall outcome. On the other hand, the per-tonne cost of some methods can reduce rapidly with increasing scale of operation.
3. ***Environmental legacy.*** Given the emergency context, the relative importance of environmental effects varies widely between stakeholders (***weighted at around 11% on average***). However, some methods of disposal are more prone to environmental risk than others because of the likelihood of poor decisions being made under pressure. Other methods are more environmentally sustainable.
4. For obvious reasons, ***biosecurity risk*** is *the* most important consideration for the responding government agency. It is the main issue affecting 'speed of resolution' (see above), but longer-term biosecurity (legacy) risks may also need to be considered. The key question is – what is the relative risk of biosecurity breaches occurring after the event has been completed and normal operation resumes? This issue was rated at a (***weighting of around 8% on average).***
5. ***Public image.*** Negative publicity must be managed but it is viewed as largely unavoidable by industry. Eradication is therefore the usual priority, in order that exposure to this risk is minimised. (***Weighted at around 7% on average)***.
6. ***Farm legacy.*** This is an important consideration for many farmers. An EAD outbreak is an extremely stressful incident for any farmer. On-farm disposal may negatively impact the mental health of the farmer. Other legacy issues include the potential impact on property values, and

whether parts of the farm need to be withdrawn from productive uses for a period. ***(Weighted at around 10% on average).***

The results of Stage 2 analysis are shown in Table 8.

Table 8. Comparison of disposal scenarios in relation to landfill.

Scenario	Disposal Method	Location	Scale	Material	Speed of Resolution Weight: 46%	Cost Weight: 18%	Environment Legacy Weight: 11%	Biosecurity Legacy Weight: 8%	Publicity Weight: 7%	Farm Legacy Weight: 10%	Overall Rating
1	Landfill	Off site	V small - V large	Carcasses							
2a	Composting	On farm	V small	Carcasses							
2b	Composting	On farm	V small - V large	Manure, sml carcasses							
2c	Composting	Off site	Large - V large	Carcasses, manure							
3	Above ground burial	On farm	Small	Carcasses, manure							
4	Trench burial	On farm	Small	Carcasses							
5	Pyre burning	On farm	Small	Carcasses							

Key (relative to landfill): Superior — Equal — Inferior

Scenario 2a may be a cost-effective choice compared to landfill, and more environmentally sustainable, but the presence of compost on farm with still-decomposing carcasses in them may adversely affect Speed of Resolution. As discussed earlier, CVOs may be reluctant to sign-off until all signs of carcass are eliminated. In contrast, Scenario 2b is less likely to be affected by this issue because the compost is comprised only of small carcasses and manure (Table 8).

The only other disposal option that could be used on a large scale is a centralised composting site, established temporarily on Crown land (Scenario 2c). Overall, this scenario comes out marginally ahead of landfill, but it is much more logistically complex to organise. Centralised composting benefits from economies of scale as it would not be worthwhile hiring specialised equipment for small volumes of carcass. To illustrate, the effect of scale (of outbreak) on the likely disposal cost per tonne of carcass was compared between landfill and centralised composting. In a small outbreak involving 3 piggeries of 100 sows each and another piggery with 500 sows, the cost per tonne for centralised composting was about 160% of landfill (Figure 36). However, if 6 farms of small-medium size were affected (e.g. 3 @ 100 sows plus 3 @ 500 sows), then centralised composting becomes competitive (on a cost basis) with landfill (Figure 36).

Above ground burial (USDA method) in Scenario 3 is competitive overall with landfill in a small-scale outbreak because it is relatively fast and cheap to set-up.

Pyre-burning has potentially many benefits with respect to environment, biosecurity and farm legacy (Table 8). Provided that there is a good supply of wood fuel at reasonable price, on-farm pyre-burning on a small scale could be a viable option.

On-farm trench burial comes out last in this analysis. It is cheap to set up but too slow for likely depopulation rates in an ASF outbreak and it has the worse legacy risks associated with it (Table 8).

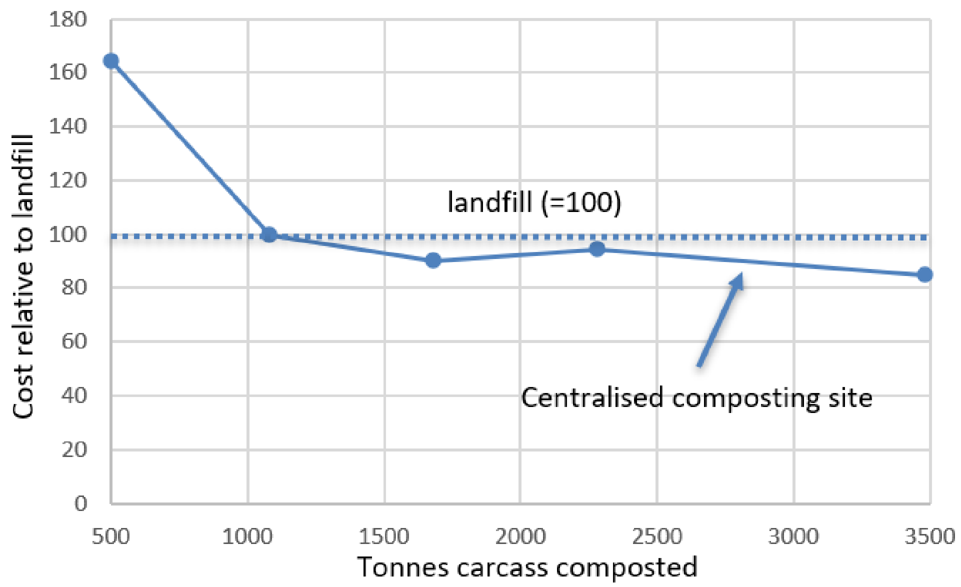

Figure 36. The effect of scale of outbreak on the relative cost of running a centralised composting site on government land compared to disposal in landfill. Modelling was conducted on the per tonne disposal costs associated with a multi-farm outbreak involving numbers of farms of various sizes.

7.5 Conclusions

Along with landfill, on-farm trench burial is one of the most favoured disposal options by government EAD response agencies. However, there is little-to-no actual experience in Australia of the use of on-farm trench burial in large scale emergencies involving the intensive animal industries other than poultry.

A rapid response is essential in an ASF outbreak, and we believe that depopulation and disposal activities must be reasonably matched. The expected rate of depopulation is about 1000 pigs per day, amounting to about 60 tonnes of carcass in a typical farrow to finish piggery. However, a reasonable day's work with one or two excavators operating could be expected to bury 20-40 tonnes of carcass per day. In addition, not all farms will have suitable sites for burial, and there is a significant risk that in the pressure of the moment, burial pits will be established on sites that would otherwise be avoided. If at all, on-farm trench burial could be used as a minor component of disposal along with other methods, especially for small outbreaks where suitable land is readily available.

Landfill is by far the most likely major disposal option in most cases. However, there will often be a role for other disposal options like composting to play a supporting role. For example, composting should be used for controlling pathogens in manure piles[6]. Small carcasses could also be included in

[6] AUSVETPLAN recommends 'decontaminating' manure piles with disinfectant, but composting would be far more effective.

such a mix – and these should readily break down within the typical timeframe of a farm that is out of commission.

There appears to be little scope for on-farm disposal, except for composting, above-ground burial and pyre-burning which could all play a minor (but important) role alongside the "heavy lifter" – landfill. Even in this case, consideration must be given to the presence or not of feral pigs. If the source of the outbreak was identified as coming from outside the feral pig population, then running an on-farm disposal operation may risk ASF becoming endemic to the country. In this case, the only on-farm disposal method that could be an option is pyre-burning.

Other than landfill, the only other off-site disposal option that is scalable is composting. In this instance we recommend the use of grinding equipment on carcasses as it would result in reduced composting times and much improved pathogen reduction efficiency. Grinding and composting has been used to good effect recently in the USA. However, this method is logistically more complex than landfill, and it must be done on a reasonable scale to make it economically and practically feasible.

To summarise, then:

- Landfill is the most competitive disposal method across most EAD scenarios.
- In some scenarios, other methods of disposal are equally or more competitive compared to landfill.
- Two composting and one pyre-burning scenarios were marginally superior to landfill in this analysis. Composting Scenario 2b (manure and small carcasses) is logistically reasonable; it would not be particularly complex to manage compared to other EAD activities that regularly take place on farm. Composting Scenario 2c (centralised composting) is far more logistically challenging, however. People will no doubt have varying opinions as to whether this increased complexity is worth the effort given the pressures likely to be experienced in an emergency. Pyre-burning is logistically more challenging than landfill, and its feasibility depends largely on the availability of wood fuel.
- Although on-farm trench burial is a favoured disposal option in many quarters, it is the least favoured method in this analysis. The main issues going against it are that it is relatively slow to set up and there are considerable environment, biosecurity and farm legacy risks associated with it. These risk factors will vary greatly from farm to farm according to site suitability and the predisposition of the farmer to having a burial site located on farm.
- Ultimately, all short-listed disposal scenarios are an option – their viability compared to landfill will vary according to individual circumstances.

7.6 Literature cited

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8. Decontamination

8.1 Summary of Decontamination Methods

The term decontamination implies bringing about the cleaning of an existing pig farm or processor building, equipment, vehicle, and site features, to a point where they do not pose a verifiable risk to disease transmission.

Following the total depopulation of a pig farm or processor site during anEAD or for any other reason, then a decontamination procedure may be applied. This aims to reduce the chance of further disease transmission and to eventually return the site to its functional operation. This has been regularly achieved in sites affected with ASF in Europe, with re-entry of pigs and negative ASF status achieved after a relatively short period.

The decontamination of a farm or processor site can be separated into four areas: farm buildings or structures, vehicles/equipment, outdoor areas, and slurry/manure areas.

There are well-established principles and practical methods for performing decontamination procedures in a structure or vehicle free of pigs. The working steps consist of:

Dry cleaning: removal of organic debris, loose materials, dis-assembly and/or removal of loose items.

Wet cleansing: thorough washing and removal of organic material with detergent and warm water.

Drying period.

Disinfection: complete surface application of liquid disinfectant capable of killing microbiological agents. Fumigation of clean structures and equipment with a suitable fogging disinfectant is then applied. This process can be repeated if necessary.

Finishing off period: re-open and dry the structure and equipment. A separate application of dry surface disinfectant (e.g. hydrated lime) may be applied.

A practical factor to be considered in decontamination procedures is that mechanical structures (e.g. vehicles or electrical equipment) are difficult to decontaminate fully. Similarly, collections of organic materials are also difficult to decontaminate, therefore feed, bedding, slurry and loose wooden components of a farm site should be subject to disposal rather than attempted decontamination.

An additional site feature that may require decontamination on a pig farm or processor site is the areas of stored slurry and solid manure.

An important choice in a targeted decontamination program is that of disinfectant. Important factors include its safety, its speed and durability of action, application rates and its visibility during usage. The choice of product must have demonstrated efficacy against the target agent, with practical consideration of its necessary contact time and kill rate at a likely operating temperature. In the case of an EAD, then the disinfectant must be quickly active, and in a persistent manner against the defined pathogen.

8.2 Previous decontamination events for Australian pigs

Pig farms and processor sites are subject to routine disinfection procedures daily. Site managers and workers are therefore familiar with the working steps as described above. Furthermore, total depopulation and targeted decontamination procedures are performed on an irregular basis on Australian pig farms for site eradication and control of endemic diseases, such as brachyspira or mycoplasma infection. These events typically involve the complete depopulation of the farm site and performing the working steps in a rigorous manner, with the use of a targeted disinfectant. The site is then re-populated with clean pigs.

No EAD event requiring large-scale DDD procedures under AUSVETPLAN planning has yet occurred in Australian pigs. Targeted decontamination procedures have been performed on the occasional pig farms and processor sites previously affected with anthrax. The suggested decontamination procedures for this EAD response are described in AUSVETPLAN for anthrax. Total depopulation and targeted decontamination procedures have also been performed several times in Australian EAD situations for sectors of the poultry industry, following incursion of avian influenza.

In Australia, the current operational manual for decontamination of a farm site, vehicle or processor site following a program of EAD depopulation and disposal procedures targeting an ASF incursion is the AUSVETPLAN version 3.2, 2008. This briefly lists the decontamination of a pig farm or processor site and vehicles by performing the working steps as described above. This manual suggests that oxidising or alkali disinfectants be used against ASF. It also suggests that insecticide products be deployed to control on-site tick populations, which may harbour ASF virus. AUSVETPLAN for African swine fever is under current development.

The Australian Government specifically addressed the choice of disinfectant suitable for decontamination of sites affected by ASF under APVMA Permit 88135. Besides oxidising and alkali disinfectants, it also authorized the use of citric acid and quaternary ammonium/glutaraldehyde disinfectants, with directions for usage.

8.3 Cleaning Procedures and Disinfectants for African Swine Fever Site Decontamination

The decontamination of a farm or processor site can be separated into four areas:

- ☐ outdoor areas,
- ☐ farm buildings or structures,
- ☐ vehicles/equipment and
- ☐ slurry/manure areas.

Following a completed decontamination procedure, it is further expected to leave the site free of pigs for a fallow period, to allow any possible remaining pockets of the target agent to disintegrate. The challenges in decontamination may be greater in an outdoor piggery.

Assuming that both depopulation and disposal procedures have been conducted on a farm or processor site affected in an EAD, such as ASF, then the following decontamination procedures would be indicated:

8.3.1 Outdoor areas

Confirm site security and local scavenger and feral pig control measures. Spray insecticide for tick control.

Surface treatment with hydrated lime. A paste of burnt or builder's lime (CaO or CaOH) is mixed with water (1:2) and brushed/sprayed onto outdoor surfaces. This generates heat and disinfection. Chemical disinfectants are not indicated on outdoor areas, due to inactivation. Leave site fallow for 45 to 60 days.

8.3.2 Buildings and vehicles/equipment

The chemical disinfection and fumigation working steps are applied thoroughly.

These procedures require considerable time and trained personnel and produce a large amount of wastewater that requires treatment or disposal. The drying period may require extra heating fan equipment. Leave farm site fallow for 45 to 60 days.

Oxidising or alkali disinfectants are considered preferable for targeted ASF disinfection procedures on farm buildings and vehicles due to appropriate contact time and kill rates at a standard application rate. Acid or chloride-based disinfectants are short acting and less effective in areas with organic materials. These disinfectants are therefore only suitable for clean processor facilities. Fumigation with formaldehyde, or an oxidising disinfectant is a hazardous task and must be performed safely accompanied. It is best performed at ambient temperatures above 20°C.

8.3.3 Manure/slurry areas

Confirm site security and local feral pig control measures. Spray insecticide for tick control. Surface treatment with hydrated lime, see Figure 37. Mix slurry with sodium hydroxide or builder's lime at 1:99 ratio. Leave site fallow for 45 to 60 days.

Figure 37. Manure pond treatment in EAD response

The suggested survival times for ASF virus in various milieu has been summarised in several scientific publications. This data has been supplemented by ASF pen studies where sentinel pigs have been challenge exposed to ASF virus in cleaned or uncleaned environments. This has been further supplemented by the field performance of DDD procedures and successful repopulation on affected farm sites. The suggested maximum time for ASF survival in a normal pig pen structure is consistently indicated to be 1 month. The suggested minimum period for repopulation of a pig farm site following an ASF incursion and relevant decontamination procedures is therefore consistently listed as 45 to 60 days.

The successful decontamination of farm sites affected by incursions of ASF has been regularly performed in Europe in the past decade, using the decontamination working steps as described above. The types of pigs, farm buildings and ancillary structures on European farms are very similar to those on Australian farms. Epidemiological considerations, such as vehicle movements and local feral pig populations are also very similar.

Besides the complete performance of the working steps listed above, necessary considerations to the successful decontamination of an EAD infected premises site have included: immediate identification and thorough decontamination of all contact vehicles, disposal of all equipment that is difficult to decontaminate, removal of access to infected site materials by likely scavengers, such as foxes, feral pigs or corvid birds (Figure 38), dismantle all farm structures as far as possible (slats, feed lines etc) and ensure proper contact times for suitable detergents and disinfectants.

Figure 38. Scavengers at ASF DDD site.

8.4 Repopulation of Infected Farm Sites

The repopulation of farm sites followed a total depopulation and targeted decontamination procedures has been performed on an irregular basis on Australian pig farms for site eradication and control of endemic diseases. Similar procedures are followed in an EAD depopulation-repopulation situation. Following the fallow period, sentinel pigs known to be free of the target disease would be sourced and delivered to the farm site. Feed and water on-site would also be tested negative. The initial sentinel pigs would consist of 5 % of the likely final population and be allowed to wander freely around the site buildings. Sentinel pigs would be tested weekly for 2 months, with all deaths to be autopsied and tested. Staff and vehicle movements to and from the farm would be restricted through the repopulation period.

The aim of successful repopulation has been regularly achieved in sites affected with ASF in Europe, with re-entry of pigs and negative ASF status achieved after a relatively short period of 2 months.

8.5 Feral Pig Contamination

Feral pigs are recognised as either likely initial or secondary points of infection in any ASF incursion into Australia (Figure 39). Because ASF is persistent in carcasses and offal, there is a high risk of local ASF-persistence via feral pigs, as well as for indirect transmission through contaminated tools and cars used during pig shooting or hunting.

Figure 39. Feral pig carcass positive for ASF

The initial management of an ASF farm site subject to depopulation would include attempted removal of all feral pigs in the local area. Following this procedure, or during an initial feral pig incursion (without farm involvement) the best practice management of feral pig infested areas generally consists of the maintenance of a core restricted area, with no hunting allowed and continuous carcass removal and testing.

This restricted area would be surrounded by an area with intensive hunting and depopulation of feral pigs. The management of an area affected by ASF-infected wild boar has been regularly performed in Europe in the past decade. There are ca. 25 million feral pigs in Australia, so total depopulation is not a likely achievement.

8.5.1 Decontamination guidelines

The AUSVETPLAN Operational Procedures Manual Decontamination Version 3.2, 2008 has a section on environmental considerations but lacks operational details. The plan provides an option for the use of temporary drains to trap and divert waste generated during decontamination and use of lined ponds or tanks for temporary storage. It also indicates the possibility to release water into waterways following treatments to neutralise chemical disinfectants, for example, oxidising disinfectants may be treated with thiosulphate. It also indicates that the fallow period may allow disinfectant chemicals, such as hypochlorite to dissipate. Other options for disposal of decontamination materials could include discharge onto wasteland sites.

The Queensland government has published specific decontamination guidance - *Procedural Guide-Incident Response 2.17 Animal Disease Outbreak Waste Management.* This sets out the requirements for the various waste types expected for a major animal disease incident and include carcasses, infected solids, infected liquids and contaminated solids. For effluent pond decontamination, the piggery is required to follow their licence conditions or industry practice, so not to cause pollution.

8.6 Bibliography – Decontamination

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9. Discussion

The necessary preparations for EAD events vary across the Australian livestock industries. Variations in production systems within each industry adds further complexity, exemplified by the complex structure of the pig industry. Individual disease agent considerations also impact on appropriate response activities. Historical importance has been given to preparations for a foot-and-mouth disease outbreak and its airborne transmission. In contrast, ASF only affects domestic and feral pigs, with transmission via direct contact. Perhaps the greatest challenge that hampers more effective preparation is that there is virtually no experience in Australia of handling an EAD event affecting pigs. Keeping exotic diseases out of the country and maintaining stringent focus on farm-level biosecurity will always be the highest priority. In this sense, our strength - remaining free of exotic diseases, is also our biggest weakness - lack of experience.

Australian Government agencies rely on guidelines in the published AUSVETPLAN manuals, as these usually carry approval for cost-sharing arrangements in an EAD response. However, these manuals in many instances fail to address the likely complexity of many livestock industry and disease agent scenarios. This review and associated stakeholder discussions identified a need for further engagement between Government agencies and the pig industry. There were identified differences in what were considered to be realistic options for mass depopulation and disposal of pigs during a major EAD event. Additionally, not all depopulation and disposal activity in any real EAD event will fall under EAD response funded cost-sharing.

State Government livestock agencies consistently advocated the use of on-site primary methods for individual pigs (captive bolt guns/firearms) as the main method of depopulation of an EAD pig population. This is likely to be partly due to its previous and familiar use in bushfire responses and its presence under AUSVETPLAN for cost-sharing. However, experienced managers of larger pig farms consider these on-site depopulation methods as being too slow, overly stressful for pigs and operators, and creating a difficult mess for disposal. The use of on-site mass depopulation methods (gas inhalation, sedatives) are advocated as superior in terms of reduced social and handling stress for groups of pigs and a reduced time frame for depopulation of animals in a contained environment suitable for disposal. Time and resource constraints are commonly experienced in EAD outbreaks, and so recognition needs to be given to mass depopulation methods that may be less resource intensive. The logistics of using captive bolts or firearms on a few quiet ruminants are of a completely different magnitude to depopulation of 10,000 boisterous finisher pigs.

Similarly, State Government environmental agencies consistently advocated the use of deep on-site trench or pit burial as the main method of disposal of an EAD pig population. This is likely to be due to its previous use in poultry EAD events, with extant standard operating guidelines. However, experienced managers of larger pig farms consider these on-site burial methods as again too slow, and associated with serious environmental, biosecurity, public health and farm legacy risks. We note the risk that burial sites may be chosen poorly under the pressures of an EAD event. While the logistics of on-farm burial are considered straightforward, since visible infected materials stays on-site, this does not address the potential leaching of burial pit contents into the local water table. Pig-proof fencing is essential for any disposal method conducted on-site (or on neighbouring properties). The use of on-site disposal methods is a particularly dangerous option if surveillance indicates that local scavenger populations (pigs, dogs, cats, corvids) are negative for ASF but carry the risk becoming infected or vectors for the disease if the burial pit biosecurity is breached.

Small piggeries have a wider array of options available compared to larger ones. Most activities can realistically be applied onto a small farm; logistical problems are amplified as pig numbers increase. It is highly likely that a mixture of euthanasia methods and disposal methods will be employed in any EAD event, even for a smaller farm. The rapid depopulation of a large pig farm or processor site would be likely to overwhelm any on-site and off-site burial disposal, leading to the need to develop large-scale composting or other disposal facilities on-site or off-site. For example, landfill space for dead livestock disposal during recent NSW bushfires was quickly filled. Lack of landfill space has also been forecast as a potential problem in Queensland.

We therefore advocate the development of operating guidelines for approved disposal methods, other than on-site burial, aimed at mass disposal of pig carcasses and related materials. These other methods are off-site disposal (e.g. in a licensed landfill), composting or burning. We note that the scientific evidence in favour of composting as a safe disposal method outweighs that attributed to on-site burial.

Queensland and NSW have enacted legislation placing greater responsibility on each agricultural industry to improve farm biosecurity. The intent of these laws is to shift the role of the State departments away from a biosecurity "policeman" to one of facilitation. It is hoped that this will assist engagement and industry preparedness for any EAD. Where a farmer preference for a depopulation and disposal program does not fit with Government agency preferences and/or is not covered under cost-sharing arrangements, solid preparation by the farmer would facilitate a successful program.

The pig industry is therefore encouraged to develop farm-specific plans for biosecurity (disease prevention) and for disease response, related to an EAD response. This should cover planning for situations where the farm is either:

i. an infected or dangerous contact premises from which pigs will need to be removed or disease free but in a declared area.

ii. While national guidelines advocate that licensed piggeries should seek pre-approval by State agencies for their own EAD plans (AUSVETPLAN 2011), the need for State agencies to retain "flexibility" in possible response operations, has made this suggested State-based pre-approval difficult to obtain and vaguely worded.

Similarly, we note that there are few national standard operating procedures for depopulation and disposal and decontamination procedures during an EAD. This again was considered due to the need for State agencies to retain "flexibility" for their own "operating environment".

We see a need to develop necessary operational guidance for those in industry and Government agencies, without hindering the capacity of the responding agencies to retain flexibility. Different EAD scenarios generate complex issues involving the scale and nature of the outbreak, local jurisdictional requirements, with common time and resource constraints. While some activities, such as landfill disposal, have an almost universal application in various scenarios, others are only suitable for more restricted use (e.g. electrocution is only possible with industrial equipment and lots of pig handling).

Given that the risk of likely transmission of ASF (via direct contact) is the same whether pigs are alive or dead, serious consideration can be given to depopulation via movement to a nearby processing facility for disposal and/or domestic human/pet consumption of cooked pork product. Some processor facilities are linked under management to substantial pig farming operations. Most domestic processors are licensed for the safe and humane destruction of all livestock, including pigs. The export market for Australian pork is relatively limited and large tonnages of pork are already imported from countries (that are PRRS-positive). The domestic consumption of pork can also be confidently predicted to drop in the face of a confirmed ASF outbreak (likely by 30 percent). Even so, some export or domestic processors may not to wish to handle ASF infected pigs, with or without relevant compensation, due to marketing issues.

The depopulation of suitable areas of a farm system to a processor facility (e.g. a finisher unit, where only the breeder unit was known to be ASF positive) would be facilitated by recognition of the compartmentalisation of sections of a farm operation, especially those with multiple sites. Industry estimates that around 35 percent of Australian farm pigs are raised on multiple site systems. This recognition would then lead to a sub-classification of each section – perhaps as a dangerous contact premises, allowing for pig inspection and their depopulation to a processor. This process would offer strong industry and community advantages over an entire farm system of several sites being declared an infected premise for immediate on-site depopulation. Detailed records of movements of stock, staff and equipment would facilitate a successful compartmentalisation and depopulation.

To address the issues raised in this review, we note the important need for Australian research into alternative methods of successful on-farm mass depopulation, and alternative methods of successful mass carcass disposal, such as gas inhalation and composting respectively.

10. Implications & Recommendations

Preparation is the key to the early and rapid response in relation to a mass mortality event or an identified EAD outbreak. Response activities must be effectively coordinated ensuring the needs of all impacted parties are met. Pre-planning of response activities is essential in identifying roles, methods and resources and assists in limiting the number of on-the-run decisions made during an EAD event.

The Australian Pork Industry is aware of the need to provide local knowledge and expertise in mass disposal and disease management and has undertaken a number of initiatives to facilitate pre-preparedness.

This literature review is the first stage in a larger pre-preparedness initiative and considers the situation on an Australian pig farm when an emergency condition, particularly an EAD, such as ASF, may necessitate the depopulation and disposal of pigs, with subsequent decontamination of the site.

10.1 Implications

Several issues have been identified in this review that could have important implications for the Australian pork industry:

- Lack of engagement between government agencies responsible for handling EAD outbreaks and the pig industry. Whilst industry and government have done and continue to work together on EAD preparedness, this engagement process appears to have been largely ineffective for the industry as a whole.
- Government and industry in many cases have different preferences with respect to the way DDD activities should be conducted. Some State authorities promulgated destruction by individual animal methods, followed by on-farm burial; a scenario perhaps suited to a single isolated EAD incident on a smaller farm. Pig industry representatives considering modern larger farm sites favoured off-site DDD methods, or on-farm destruction by group methods, followed by off-site disposal.
- Few operational-level guidance materials or SOPs exist aside from on-farm burial. Furthermore, most of the guidance material that is available is targeted at government decision makers or for non EAD events. The lack of guidance materials targeted at producers limits their ability to prepare for an event.
- Although DDD response activities need to be assessed on a case by case basis, the lack of nationally consistent operational-level guidelines means that jurisdictions will often be forced to make decisions on the fly with little clear direction.
- Piggeries would benefit from the ability to develop and seek approval for their own EAD response plans, but this will be difficult to achieve due to these inconsistencies. The impact of an EAD outbreak could be unnecessarily aggravated by government and industry not reaching agreement on key issues.
- On-farm disposal methods are limited by uncertainties surrounding capacity issues and concerns around environmental, biosecurity risks and farm legacy impacts. On-farm disposal options can be envisaged for small outbreaks. In larger outbreaks, off-site disposal options are more realistic, supported by some on-farm disposal.

- There are only two options for carcass disposal that are potentially scalable (i.e. suitable for use in small and large outbreaks). These are landfill and composting. Landfill is likely to be used in many cases, but some areas are affected by capacity limitations. The potential use of large-scale composting is limited by lack of confidence, expertise and guidance materials available to State agencies.

10.2 Recommendations

- APL should develop a government engagement strategy with respect to ASF preparedness. The strategy should build on areas of common understanding and target key issues of difference with respect to DDD activity planning.
- Develop training programs for biosecurity and EPA staff to upskill them with respect to DDD methods applicable to multiple EAD scenarios in piggeries. There is a general lack of expertise in pig production in government biosecurity and environmental departments.
- Establish a database of experts in DDD aspects for industry and government to draw on. Access to expertise in some fields (e.g. composting) limits the prospect of some disposal options being used in an emergency.
- Work with industry and government to develop a common understanding of the potential to use processing facilities where possible for disposal of pork from ASF-affected farms allowing for subsequent domestic human/pet consumption of cooked meat.
- Develop nationally consistent SOPs for DDD methods, particularly with respect to mass depopulation methods (e.g. sedative overdose and use of inhalant gas) and disposal (e.g. composting, burning and above-ground burial).
- Develop guidelines for DDD methods that are especially targeted for use by the pig industry in the development of their own EAD biosecurity plans. Most of the guidance materials that are available are written for internal use by government biosecurity agencies and are not necessarily suitable for industry use.
- Government agencies are very often constrained by the perception that there are few choices available and that on-farm burial is therefore unavoidable, despite the risks associated with it. Therefore, research is needed to:
    - Examine the biosecurity, human health and environmental risks associated with on-farm mass burial; determine the adequacy of existing Australian guidelines that are relevant to pigs; develop new guidelines that minimise these risks.
    - Conduct research on the suitability of other on-farm mass disposal methods such as composting, burning and above-ground burial; develop guidelines that are relevant to pigs.
    - This research, though sponsored by industry, needs to involve significant government engagement.
- As landfill space in some cases may be limited, research is needed on finding off-site disposal alternatives that are suitable for use on a large scale. In particular, the merits of carcass grinding and composting should be investigated – e.g. resources required, economics, logistics and biosecurity aspects.

- Conduct further work on EAD scenario planning involving piggeries of multiple scales and types in different locations, sharing the findings with both industry and government.
- Develop templates for the development of EAD biosecurity plans by the Australian pig industry.

11. APPENDIX A: National and State Environmental Regulations and Requirements

	AUSVETPLAN
AUSVETPLAN manual	• AUSVETPLAN Operational Manual Disposal Version 3.1, 2015 • AUSVETPLAN Operational Procedures Manual Decontamination Version 3.2, 2008
Disposal preference	No Preference: Approved Methods include: Burial Burning Rendering Composting Anaerobic digestion Alkaline hydrolysis Leave in situ Ocean disposal Refeeding to non-susceptible species Appendix 8 provides a sample decision making process for determining appropriate disposal options
On site Burial requirements	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* Addition of lime not recommended Some jurisdictions have weight or volume limits for material for disposal, above which the need for environmental agency approval is triggered. Note: No EPA indicated a volume limit as an emergency authorization available • Preferable not in a drinking supply catchment • Should be located away from towns, dwellings and major roads • Should preferable be on soils of low permeability (any soil with significant clay content/ Consider lining if soil type unsuitable • Seasonal maximum groundwater depth should be below the base of the burial pit. Level determined by EPA • Should be away from any watercourses, lakes, ponds and so on. This includes natural or dammed fresh water, aquaculture ponds, tailings ponds, sewage treatment ponds, reservoirs and water tanks. The distance from the watercourse needs to be approved by the environment protection agency. • The site should be a sufficient distance from the coast. • The site should be a sufficient distance from World Heritage areas, conservation areas and Indigenous cultural sites (including midden sites) • Distances vary according to state/territory and local regulations; environmental agencies should be consulted. • The site should be accessible to trucks and earthmoving equipment, allowing them to enter easily and be effectively disinfected. • The site should preferably not be on a slope greater than 6% and should allow digging of 5-metre deep pits with heavy equipment. Effective leachate management must be included in early planning, such as by the inclusion of drainage to collection points in pit bases, with inspection points and pump-out wells installed at appropriate locations, depending on pit design. Advice must be sought from relevant environment protection agencies on the programs required for containment, treatment and monitoring of leachate.

Remediation requirements for trench burial and mounding will depend on local environmental regulatory requirements.

Regular inspection of unlined mass burial sites after closure is recommended so that appropriate action can be taken in the event of movement of leachate in the soil profile or other problems.

When using an existing commercial landfill facility, some base level of security will exist for the facility; this may need to be increased, in consultation with the facility's management.

When using a commercial landfill facility, burial works will usually be conducted by employees of the existing facility on a contract basis. The specifications of the contract will be decided by the expert team. The facility will normally have, or have access to, its own resources. IPS personnel will be responsible for biosecurity at the site.

Remediation requirements for a commercial landfill facility will already be part of the facility's management planning.

For all burial categories, a disinfection area will need to be constructed to allow disinfection of vehicles, personnel and equipment leaving the burial site.

Appendix 3 has an **Environmental Checklist** for wastes which includes the plus the following on burial:

<u>Assessment</u>

- Check whether the soil at depth is nonpermeable, and the integrity of the soil is such that it will retain leachate over time.
- Assess soil acidity.
- Check whether the bottom or sides of the pit show signs of fissures that might result in loss of containment.
- Assess the need for liners to be used, if the soils may not provide sufficient protection of groundwater.
- Plan whether leachate should be collected or processed, and the need for leachate to be treated.
- Assess whether gas generation from putrescible waste is likely to be a problem, and plan how the gases generated from the site will be released or processed

<u>Operational</u>

- Obtain any necessary permits.
- Assess the availability and timeliness of supply of suitable liner and capping material, if required.
- Assess the requirement for capping material and the type to be used.
- Assess the monitoring regime to be implemented for the burial site, leachate system, gas system and groundwater.
- Assess likely subsidence of the pit with the total decomposition of the buried carcasses, and implement appropriate contingency plans to remediate this.
- Assess the need for medium-term mitigation of risks to the public

Landfill

<u>Assessment</u>

- Assess the availability of suitable landfills within a practical distance.
- Assess the licence type and quality of management of the landfill site. Assess the need for extra biosecurity procedures and measures at the site, and training for site personnel.
- Check whether the use of the landfill is likely to cause short-, medium- or long-term problems for the local community because of diminished capacity as a result of its use in the EAD response.

<u>Operational</u>

- Check the monitoring procedures that are required.
- Develop a monitoring plan for biosecurity measures implemented

	Appendix 6 Burial pit construction. Provides information on earthmoving equipment, burial pit construction Relevant information is as follows: • 1.5 m3 per cow. • 0.3 m3 per pig or sheep. • Minimum depth of pit: 5 m. • Required depth of soil to cover carcasses: 2 m. It provides a calculation to determine how many animals per pit size
On site Composting requirements	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* When conducted properly, composting should not result in excessive odour problems. Peak odour emissions occur during the turning of composting piles (if conducted), although these usually settle down quickly when turned piles are re-covered with new co-composting material Composting should not result in pollution of groundwater, provided that the depth of the base layer is sufficient. Any leakage of fluids from piles should be immediately attended to by the addition of more absorbent co-compost material. Care should be taken not to overwater compost piles. Composting in cold temperatures may increase the time taken to reach suitable temperatures. Monitoring is mainly required during the composting process itself, and includes monitoring of compost temperatures, leachate and odour. Monitoring of compost, or sites where composting has been conducted, is not normally required after the process has been completed. Acceptable uses for the final compost product need to be determined. The finished product may need to be tested for nutrient composition and microbiological profile The first stage of composting is usually complete within about 3 weeks for poultry, and up to 12 weeks for larger carcasses. The second stage takes an additional 3 weeks for poultry and up to about 8 months for larger animals (but this will vary). Pre-treatment of carcasses (e.g. by grinding) will reduce compost times and co-compost material volumes, but will increase biosecurity risks. Manage process and site as per standard operating procedures. Monitor compost windrow conditions and infectivity Ownership of compost end products needs to be established at start of process. Potential markets and users need to be identified

	Appendix 3 has an **Environmental Checklist** for wastes which includes the plus the following on composting: <u>Assessment</u> • Assess the availability of sufficient suitable land on the infected premises or within practical distance from the infected premises. Check whether an existing commercial operation can be used. • Assess the need for management practices to protect the environment. • Ensure that a suitable source of the carbon required for composting is available. • Assess the need for extra biosecurity procedures and measures at the site, and training for site personnel. • Assess the options for using or disposing of the final compost product (e.g. farms with or without livestock, forest land, gardens, disposal to landfill or other burial). <u>Operational</u> • Assess the availability of ongoing expertise to manage the process. • Plan the implementation of best-practice management of the site. • Ensure that measures to protect the site from predators and feral animals are in place. • Assess the need for monitoring procedures for the site.
On site burning requirements	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* Impacts can be reduced through appropriate siting of operations on the property, good design and management of pyres or pits, and effective communication with neighbours and property owners. Personnel should ensure that all possible controls are implemented to reduce the risk of fire spread (e.g. adequate cleared area, adequate supervision, presence of firefighting capability, fire permits, notification of burn times). Identification of underground and above-ground utilities should be part of any initial property risk assessment. Good access is required to deploy machinery to supply fuel, construct the pyre or pit, maintain the fire and dispose of ashes. Open-air burning can pose risks to groundwater, although this is usually only if liquid fuels are used for initiating burns. The main environmental impacts are relatively short term and largely relate to air quality. The necessity to monitor air quality and provide site remediation should be negotiated with jurisdictional environmental agencies. Return the burn site to a reasonable condition. Burying of ashes on-site or disposal to landfill off-site, followed by clean-up using machinery, should facilitate this process. Typically, additional monitoring and site remediation are not required for commercial incineration methods, apart from decontamination requirements

On site burning requirements (cont)	**Appendix 3** has an **Environmental Checklist** for wastes which includes the plus the following on burning: <u>Assessment</u> • Check the direction and speed of the prevailing winds and other likely winds, and ensure that contingency plans are available if wind direction changes. • Check that the current weather and weather forecast in the area are favourable for pit/pyre construction and burning. Ensure that fuels of appropriate quality and quantity are available. • Ensure that plans are in place to minimise emissions and air pollution. • Ensure that care has been taken in construction to ensure that runoff from the site does not cause pollution of waters or site contamination. • Ensure that the smoke generated by the fire does not cause an aviation hazard or adversely affect the community. • Ensure that the pyres as constructed will result in 100% kill of the EAD agent. <u>Operational</u> • Check that no fire ban or no-burn day is current, and that appropriate permits have been obtained. • Check that arrangements have been made to dispose of ash and minimise the risk of leaching. • Ensure that personnel constructing the pyre or pit have been trained in its construction to maximise the efficiency of the burn. • Ensure that smoke from the fire is minimised and burning is efficient. • Ensure that air-quality monitoring is planned. • If pits are constructed, ensure that site remediation is planned **Appendix 7: Pyre Construction** Provides general information on pyre construction. Typically, pyres are rectangular in shape, with the long edge at 90 degrees to the direction of the prevailing wind. When timber is used as a solid fuel source, the bottom row should be parallel to the wind, with a gap between the lengths equivalent to the diameter of the timber pieces. The second layer should be placed at 90 degrees to the first layer, again with a gap between lengths. This cross-hatching should continue until the desired height is achieved. Larger-diameter timber should be used at the base of the pyre and smaller timber towards the top. Additional trenching underneath the pyre may improve airflow but is not necessary if the pyre is constructed in the above manner. A well-constructed large pyre should consume carcasses within 24–48 hours. The remaining ashes should be disposed of by burial on-site.
Anaerobic Digestion (AD)	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* Estimated that digesters can handle 3.6 kg of meat per cubic metre of digester capacity per day. It takes 4–6 months to construct and start up the digester, so existing facilities would need to be used.

Effluent and Manure Management **Decontamination**	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* Manure can be stored in piles or windrows (with no co-compost material) for a period that is sufficient to destroy the EAD agent. The pile is covered to protect it from the weather and birds, and the temperature is monitored frequently to demonstrate that the pile has reached a sufficient temperature for the period required to inactivate the EAD agent. *AUSVETPLAN Operational Procedures Manual Decontamination Version 3.2, 2008* Although selection of the disinfection method will be undertaken primarily on the basis of effectiveness against the target EAD agent, disinfectants used in disease control programs are potentially noxious substances and may have adverse impacts on the environment. The planning process needs to consider in advance the potential environmental impact from decontamination procedures and assess whether methods for containment or neutralisation are viable and acceptable It is a common requirement in all states and territories that activities should not have significant detrimental impact on the natural environment. As such, the discharge of chemicals, silt, organic matter or carcases into natural waterways or other environments may be deemed an offence. It is essential that authorities are consulted when the decontamination process is being designed and that appropriate disposal of waste materials is undertaken. The volumes of water requiring disposal will need to be considered during planning. In some cases, it may be possible to release water into waterways following treatment to neutralise chemical disinfectants (for example, treatment of oxidising disinfectants with thiosulphate) or following a prescribed period of time that allows chemicals to dissipate to acceptable levels (for example, hypochlorite and chlorine dioxide). Other options could include discharge onto approved wasteland sites. Thorough cleaning before disinfection, use of protective clothing and equipment, use of temporary drains to trap and divert waste, and use of lined ponds or tanks for temporary storage are all options to reduce the adverse effects of decontamination activities on the environment.

Other AUSVET PLAN Appendix 3 Enviro Checklist General	*AUSVETPLAN Operational Manual Disposal Version 3.1, 2015* **Wastes** <u>Assessment</u> • Check whether the potential for beneficial reuse of the material, rather than disposal, has been assessed. • Check that waste minimisation and management plans are in place for the activity. • Check that all likely waste products have been classified and disposal method(s) have been identified. • Check that biohazards posed by the emergency animal disease (EAD) agent have been assessed. • Check that measures to inactivate the EAD agent have been identified **Site** <u>Assessment</u> • Check that the proposed sites for treatment and disposal have been identified and GPS coordinates recorded. • Check that relevant topographical, geological and hydrological characteristics of the site have been identified. • Check the distance of the site from population centres, and the direction of the prevailing wind. • Check whether the site is located within an environmentally sensitive or protected area. • Check whether use of the site is restricted or prevented by a legal instrument, planning instrument, declaration, agreement or other device. • Check that the necessary environmental and planning approvals for the activity can be gained in a timely manner. • Check the previous land uses of the site. • Check if the site is potentially contaminated and, if so, consider how this can be managed. • Check whether contamination of the site could result from the activity. • If an environmental impact statement is needed for approval of this type of activity, ensure that the required information is available. • Assess the risks to the local ecosystem or other wildlife, including aquatic life. • Assess whether the activity is likely to have an impact on any future use of the area. • Ensure that a process is planned to consult neighbours and stakeholders about the proposed activity. • Check whether rehabilitation plans are needed for the site after the activity. <u>Operational</u> • Check whether mitigation procedures for odour or air pollution are needed and have been put in place. • Check whether mitigation measures for noise and vibration are needed and have been put in place. • Check whether dust mitigation measures are needed and have been put in place. • Check plans for optimum prevention of site contamination. • Check the need for vermin control to minimise the risk of disease transmission outside areas that are already contaminated. • Check that environmental protection measures will be put in place during the construction phase. This is especially important if heavy equipment is used, because of the need for sediment and erosion control. • Ensure that personnel have been adequately trained in the use of chemicals and other materials classed as dangerous goods or hazardous substances. • Ensure appropriate security measures for environmental protection and protection of human health. • Ensure that appropriate environmental monitoring and recording systems are in place.

Weather

Assessment

- Check that the current weather and weather forecast for the area of disposal are favourable.

Water

Assessment

- Check that surface water (rivers, creeks, lakes, dams, etc) in the area is an appropriate distance from the site, and consider containment methods.
- Assess whether surface water could be polluted or otherwise affected.
- Ensure that the surface water is not a source for drinking water supplies.
- Assess the drainage of surface water, and how receiving waterways and downstream waterways may be affected by the proposed activity or ongoing activities.
- Assess the survival of the EAD agent in water.
- Assess the presence and depth of aquifers in the area.
- Assess the likely future movement of the watertable.
- Assess the current and possible future use of groundwater under the site.
- Assess the permeability of the soils surrounding the operation.
- Assess options to prevent pollution of groundwater

VICTORIA

Victoria	
Environmental legislation and guidelines	• *Environment Protection act 1970* • Environment Protection Amendment Act 2018 (will become Environment Protection Act 2017) • EPA Publication IWRG641.1 Farm Waste Management – June 2019 • Disposal of bushfire waste EPA Publication 1738 – March 2019 • Guidelines for on-farm burial of animals in an emergency animal disease response – AGRICULTURE VICTORIA, 2020 • DJPR Incident Action Plan- ASF • Incident appreciation process (draft) Vic • Identifying and activating a stand-alone mass animal burial facility guidelines, 2020 (Off site) • DJPR Carcass Disposal Options Analysis Map (Off site) • Site assessment for mass burial reports • Disposing of carcases and contaminated materials to licensed landfills-Guidance Document, Victoria Government (Offsite) 2019 • DJPR SOP Incineration of carcases using an above ground 'Burn Boss' air curtain incinerator 2020- no environmental requirements • Disposing of carcases after bushfire flood or drought AgNote Number: AG1371, Agriculture Victoria
Environmental Authorizations	Yes-but will also need to align with EPA Publication IWRG641.1 Farm Waste Management – June 2019 Emergency 30A under current *Environment Protection Act 1970* *Environment Protection Amendment Act 2018.* Part 7.4 enables the Authority to authorize a temporary discharge, emission, deposit, storage, treatment or handling of waste in the case of a temporary emergency, a public nuisance or other specified circumstances. **Part 7.4—Authorization of discharges or disposal** **157 Authority may authorize emergency storage, use etc. of waste** (1) Despite anything to the contrary in or under this Act, the Authority may, on application under this section, authorize— a) the discharge, emission or deposit of waste from any place or premises into the environment; or b) the storage, treatment, handling or disposal of waste on or from any place or premises. (2) The Authority must not grant an authorization under this section unless it is satisfied that the authorized activity will not have significant adverse effects on human health or the environment, and that the authorization is for the purposes of— a) meeting a temporary emergency; or b) providing for the temporary relief of a public nuisance or community hardship; or c) enabling the commissioning, repair, decommissioning or dismantling of any item of plant or equipment. Authorizations can be granted for on-site disposal or for offsite facilities.
Waste Levy Exemptions	Yes

	Environment Protection Amendment Act 2018 **146 Minister may waive the requirement to pay waste levy for the purposes of the disposal of waste generated from a temporary emergency** (1) The Minister may waive the requirement to pay a waste levy under section 145 for the purposes of— a) the disposal of waste generated from a b) temporary emergency; or c) the temporary relief of a public d) nuisance or a community hardship. Authorized by the Chief Parliamentary Counsel (2) A waiver under subsection (1) may specify— a) the area to which it applies; and b) the waste or types and categories of waste to which it applies; and c) the premises subject to the waste levy to which it applies; and d) the period of time (not exceeding 120 days) for which the waiver applies; and e) any conditions on the waiver that the Minister considers appropriate.
EPA Role	Waste Disposal. Work alongside Agriculture Victoria to identify suitable disposal options. If an event occurred EPA would assess on a site by site basis and work with landholder to identify the nearest licenced facility to take the material or grant the facility an emergency licence to accept material. An emergency authorization can also be granted for on-site disposal especially if outside the requirements of current guidance.
Disposal preference	1. Off farm disposal to a licenced Landfill or renderer (can use unlicenced or closed) 2. On farm disposal if disease/scenario permits in accordance with guidance (Wastes on farms) and AUSVETPLANs 3. Pre-approved site- No current sites but DPI have identified 3 potential sites currently being assessed

On site Burial requirements	

On site Burial requirements

EPA Approval

Producers will have to comply with the requirements in the farm wastes guidelines for any disposal option on site. *Farm waste management Publication IWRG641.1 June 2019*. Although it doesn't cover composting or burial.

Should be:

- on elevated land with a slope of less than five per cent, to allow proper drainage and prevent pooling of water following a rain event
- at least two metres between the watertable and the base of the pit, considering site specific geology and impact into groundwater
- at least 200 metres from any surface waters
- at least 300 metres from neighbouring houses
- avoiding highly or moderately permeable soils.

You should also:

- cover the carcasses with at least one metre of soil
- where necessary, direct surface run-off away from the pit
- slightly mound the pit after backfilling.

You may want to install temporary fencing to assist reinstatement of the area.

DJPR Guidance

Guidelines for on-farm burial of animals in an emergency animal disease response – AGRICULTURE VICTORIA, 2020

As part of this process Agriculture Victoria staff should contact the EPA (1300 372842) and seek immediate assistance with a site assessment and consideration of a section 30A (Environmental Protection Act) emergency discharge approval. The below guidelines should be used by DJPR staff to assist with this process;

As a guide an on-farm burial site should be located:

- on heavier soil of low permeability and good stability
- on elevated land but with a slope of less than 5% (preferably less than 2%)
- above the 1 in 100 year flood level* *Different to guidance above*
- at least 200 metres from any surface water (creek, river, lake, spring) * *Different to guidance above*
- at least 200 metres from any ground water supply (stock and domestic bore) * *Different to guidance above*
- at least 2 metres from the bottom of pit to the watertable level
- at least 300 metres from any sensitive use (e.g. neighbouring house)
- a safe distance from underground and aboveground infrastructure (e.g. powerline, telephone line, gas line, waterpipes, sewerage)
- well away from the view of the general public. * *Different to guidance above*

	Operators should also: • cover the carcases with at least 2 metres of soil* *Different to guidance above* • slightly mound pits after backfilling to allow for subsidence and promote runoff rather than infiltration • where necessary, excavate cut-off drains upslope of the burial pits to direct surface run-off away from the pits • where possible, plan destruction activities close to burial site* *Different to guidance above* • have good, safe access to site for machinery * *Different to guidance above* Other factors that need to be considered are: • any requirements for monitoring (EPA) • any requirements for leachate and gas management (EPA) • any requirement for use of synthetic liners in pits (EPA) • any native flora and fauna planning controls (local, state and federal) • any heritage overlays, native title and covenants *DJPR Incident Action Plan- ASF* **On-farm trench burial (with partial composting)** Bury on-site with excavator • Use carbon materials (hay, straw, feed) at the base of pit to soak up leachate and as a daily cover to provide for a partial composting process. Keep pit open (with carbon cover) for as long as practically possible to maximise oxygen use for composting and passive release of gases. • Using on-farm burial suitability criteria (Carcass Disposal Options Analysis Map) several areas on the site appear suitable. • Preferred site is (description of proposed area) due to proximity to destruction area, suitable distance to groundwater (modelled) and suitable soil type. • Owner does not think groundwater is an issue for burial. (Need to seek information from EPA at site visit i.e. groundwater, surface water etc) suitable distance to groundwater (modelled) and suitable soil type. *Disposing of carcases after bushfire flood or drought AgNote Number: AG1371, Agriculture Victoria* On farm burial requirements are the same as for Guidelines for on-farm burial of animals in an emergency animal disease response – AGRICULTURE VICTORIA, 2020 **DJPR have following guidance for Offsite burial:** *Identifying and activating a stand alone mass animal burial facility guidelines, 2020 (Off site)* *DJPR Carcass Disposal Options Analysis Map (Off site) Site assessment for mass burial reports* *Disposing of carcases and contaminated materials to licensed landfills- Guidance Document, Victoria Government (Offsite)* 2019
On site Composting requirements	No EPA Guidelines regarding emergency composting. - No DJPR guidance.

On site burning requirements	No EPA Guidelines regarding emergency burning. -No DJPR guidance for pyres DJPR SOP Incineration of carcases using an above ground 'Burn Boss' air curtain incinerator 2020 - no environmental requirements
AD	No Guidance
Effluent and Manure Management **Decontamination**	No guidance on decontamination

QUEENSLAND

	Queensland
Environmental legislation and guidelines	• *Environmental Protection Act 1994* • *Waste Reduction and Recycling (Waste Levy) Amendment Act 2019* • *Disaster Management Act 2003* • DAF Establishing a mass burial facility for disposal of carcasses and material contaminated with an infectious emergency animal disease agent 24 May 2016 • DAF Developing a risk atlas to support mass burial facility site selection in Queensland • Procedural Guide Incident Response ABN 46 640 294 485 November 2019
Environmental Authorizations	Yes **Part 4 Environmental Protection Act 1994 of Emergency powers of authorized persons** **466A Application of pt 4** This part applies if an authorized person is satisfied on reasonable grounds that an emergency exists. **467** Authorized person may take or direct someone to take stated action (1) To deal with the emergency, the authorized person may— a) give a direction (an emergency direction) to a person to take stated reasonable action within a stated reasonable time, including to release a contaminant into the environment; or b) take the action, or authorize another person to take the action. (2) The authorized person may impose reasonable conditions on the direction (3) The direction may be given orally or by written notice. (4) However, if the direction is given orally, the authorized person must, as soon as practicable, confirm the direction by written notice given to the person. **Part 4A. Temporary emissions licences** 357AAA Definition for pt 4A In this part— applicable event see section 357A. **357A** What is an applicable event An applicable event is an event, or series of events, either natural or caused by sabotage, that— a) was not foreseen; or b) was foreseen but, because of a low probability of occurring, it was not considered reasonable to impose a condition on the authority to deal with the event or series of events; when particular conditions were imposed on an environmental authority, when a transitional environmental program was approved, or when amendments to an approved transitional environmental program were approved.

	357B Who may apply for temporary emissions licence (1) A person may apply for a licence (a temporary emissions licence) that permits the temporary relaxation or modification of— a) particular conditions of an environmental authority; or b) particular requirements or conditions of a transitional environmental program; that relate to the release of a contaminant into the environment in response to an applicable event (Definition 357 AAA). **Schedule 1** Exclusions relating to environmental nuisance or environmental harm sections 17A, 440 and 440Q Part 1 Environmental nuisance excluded from sections 440 and 440Q **2 Government activities and public infrastructure** Environmental nuisance caused in the course of any of the following activities— c) performing a function under the Disaster Management Act 2003;
Waste Levy Exemptions	Yes *Waste Reduction and Recycling (Waste Levy) Amendment Act 2019* **26 Disaster Management Waste** means waste generated by or because of a disaster that is or has been the subject of a declaration of a disaster situation under the Disaster Management Act 2003, but only within the limits, if any, declared by the chief executive, by publication on the department's website, for a particular disaster. **26 Definitions for chapter** exempt waste means— a) disaster management waste; (aa) serious local event waste; or b) waste approved by the chief executive to be exempt waste for a particular exempt waste application; or ***Disaster Management Act 2003*** 13 Meaning of disaster (1) A disaster is a serious disruption in a community, caused by the impact of an event, that requires a significant coordinated response by the State and other entities to help the community recover from the disruption. 16 Meaning of event (1) An event means any of the following— c) an infestation, plague or epidemic; Example of an epidemic—a prevalence of foot-and-mouth disease

EPA Role	QDES work with primary industries regarding disease incidents and are responsible for the waste management aspects Identify suitable on-site locations and offsite facilities if required.
Disposal preference	1. On site disposal is the preference in accordance with disposal plan (DPI) 2. If transport allows a dedicated facility such as State-owned land operated to a temporary environmental licence (see below) and managed by an external contractor. Licensed disposal sites (landfills, incineration, composting, rendering) are an option but have limitation in QLD due to size and remoteness Because of the small size of most of the existing licensed disposal facilities in Queensland, it is highly unlikely that any would be appropriate for large scale events involving 1,000's of cattle equivalents. For medium events involving 100's of cattle equivalents, the largest category of regulated waste landfills, ERA 60(1)(d), may be appropriate. For small events involving 10's of cattle equivalents, the smaller categories of regulated waste landfills, ERA 60(1)(a, b, c), should be appropriate.
On site Burial requirements	*DAF Establishing a mass burial facility for disposal of carcasses and material contaminated with an infectious emergency animal disease agent 24 May 2016* Adapted from AUSVET PLAN Disposal procedures 2015 • The site will not be within 10 kilometres of a town water supply intake. • The site will not be within 300 metres of a borehole used for drinking water. • The site will be located on soil of low permeability and good stability. • Groundwater depth at the site will be at least five metres from the bottom of pit. I.e. minimum 5 m deep pit + 5 m buffer = 10 metres surface to groundwater level. • The site will be more than 500 metres from any watercourse. • The site will be outside known flood zones. • The site will be more than 2 kilometres from the coast. • The site will be accessible to multiple large trucks and earthmoving equipment, allowing unhindered entry-exit and space for decontamination of vehicles and large machinery. Refer Criterion 9 - Site Area. • The site will be more than 250 metres from underground and above-ground infrastructure (such as a powerline, telephone line, gas line, water pipes, sewerage). • The site will be on elevated land but with a slope of less than 6% (3.5°) (preferably less than 2% (1.15°)). • The site will be more than 2 kilometres from a town. • The site will be more than 1 kilometre from any dwelling. • The site will be at least 5 hectares. • The site will be at least 200 metres wide. • The site will not be within 1 kilometre of a World Heritage Area. • The site will not be within 250 metres of a national park or conservation area or indigenous cultural sites (including midden sites). Guidelines also has information on Pit type and dimensions, liner design, leachate management system, inside the burial pit, outside the burial pit, management of carcasses, gas management and biosecurity. Environmental implications include: • Preferred type is "cut and fill" on a Greenfield / undeveloped site (trench type pit). • An alternative option is a non-trench type pit, resembling conventional landfill cell. • Liner options may include: Clay; Geomembrane; A combination of materials. • A leachate management system (with gravity feed) to facilitate collection in a sump at one end of the pit for should be installed as part of initial pit design and construction

	• Design of leachate pit i.e. 300mm depth stone drainage described The preferred option for a leachate storage system is leachate evaporation through purpose built ponds. It is recommended that: • Every two layers of carcasses be covered with a 150 - 200 mm layer of soil; • At least 300 mm of soil cover is added at the end of daily burial operations (daily cover); • At least 2 metres of soil be placed over carcasses when the pit is full (final cover). • Depending on the amount of gaseous by-products (subject to estimation during the detailed design of the mass burial facility), gas collection and management systems may be required. Guidance document: *DAF Developing a risk atlas to support mass burial facility site selection in Queensland* Sets out the same site assessment criteria as above for the development of large scale mass mortality sites *Procedural Guide- Incident Response 2.17 Animal Disease Outbreak Waste Management* ABN 46 640 294 485, November 2019 Attachment 9 – DES Criterion for land suitability for mass burials • The site should be more than 200 metres from any surface water (e.g. pond, stream, wetland) or bore. * *Different to guidance above* • The site should be on soils of appropriate low permeability. • The seasonal maximum groundwater at the site should be more than 5 meters below the base of the burial pits • The site will not be within 500 metres of the coast or from any high conservation value areas (e.g. National Parks, World Heritage areas, Ramsar areas, threatened species habitats, wetlands or high conservation areas). * Different to guidance above • The site will be more than 500 metres from any dwelling or sensitive place (e.g. schools, shops, business). * Different to guidance above • Sites should be above the 1:100 year flood level. * Different to guidance above • The use of the site will not interfere with any Aboriginal traditional ownership values. * Different to guidance above • The use of the site will not interfere with any Aboriginal or other cultural heritage values. * Different to guidance above • The site should be accessible to large trucks and earthmoving equipment and allow them to enter easily and be effectively disinfected on site. • The site should not be on a slope greater than 2% to 6% and allow digging of 5 metre deep pits with heavy equipment. * Different to guidance above • The site should be greater than 5 hectares in area and must be more than 200 metres wide. • The geology of the site must be suitable, with no bedrock within 5 metres. * Different to guidance above
On site Composting requirements	No Specific Guidelines regarding emergency composting. Composting is a relatively complicated process which requires high levels of supervision over extended periods to be effective. Adverse effects may include widespread odour issues as well as leachate contamination of surface and ground waters.
On site burning requirements	No Guidelines regarding emergency burning. Meet general environmental duty On-site burial and burning may be appropriate for a smaller incident. Most incinerators are only designed to process small quantities of biological materials.

AD	No guidance on AD
Effluent and Manure Management **Decontamination**	*Procedural Guide Incident Response 2.17 – Animal Disease Outbreak Waste Management* ABN 46 640 294 485 November 2019 Department of Environment and Science www.DES.qld.gov.au Sets out requirements for Waste types for major animal disease incidents including: Type 1 – Carcasses. Type 2 – Infected solids. Type 3 – Infected liquids. Type 4 – Contaminated solids. Type 5 – Contaminated liquids. Type 6 – General solids. Type 7 – General liquids. Includes a list of contractors who have been contracted to transport wastes and facilities engaged to receive wastes for disposal for each of the waste categories There are 2 purpose built mass burial facilities constructed for carcass disposal at Kilcoy and Lowood Chemical use regarding decontamination i.e. washed into effluent system would be assessed on a case by case basis and would need to adhere to the general provisions of the EP Act re contamination. May need NPK test effluent and suitability for land irrigation Could use STP guidelines for irrigation or licence requirements Follow licence conditions re effluent management and land application (if licence) or industry best practice so not polluting If no licence follow general environmental duty

NEW SOUTH WALES

	New South Wales
Environmental legislation and guidelines	• *Protection of the Environment Operations Act 1997* • Protection of the Environment Operations (Waste) Regulation 2014 • Animal carcass disposal December 2017, Primefact 1616, first edition, Animal Biosecurity, NSW DPI. • Procedure – Disposal of large animals NSW DPI, Sept 2008 www.dpi.nsw.gov.au /climate and emergencies / emergency/ management/ resources and publications have a wide range of resources targeted at involved agencies including: • Task risk assessment for animal destruction and disposal activities in emergencies • Animal-biosecurity-pig-field-investigation-questionnaire
Environmental Authorizations	Yes *Protection of the Environment Operations Act 1997* **Part 9.1 Exemptions** **284 Exemptions by EPA in emergencies and other situations** (1) Exemptions The EPA may exempt any person or class of persons from any specified provision or provisions of this Act or the regulations, in the circumstances referred to in subsection (2). (2) Situations where exemptions may be granted An exemption may be granted in— a) an emergency (including, for example, fires, floods and fuel shortages), or b) circumstances where— I. the EPA is satisfied that it is not practicable to comply with the relevant provision or provisions, by implementing operational changes to plant or practices, and II. the EPA is satisfied that non-compliance with the provision or provisions will not have any significant adverse effect on public health, property or the environment, and III. (iii) the Board of the EPA approves the granting of the exemption.
Waste Levy Exemptions	Yes Not all facilities charge a waste levy. Generally charged only along the coast and not in areas where piggeries are located. Protection of the Environment Operations (Waste) Regulation 2014 **Part 2 Division 5 Clause 21** **21 Certain types of waste exempted from calculation of contributions (cf clause 10(1) of 2005 Reg)** Note. An exemption from the requirement to pay contributions under section 88 of the Act may also be granted by the EPA under Part 9 in relation to certain types of waste. (1) The following types of waste received at a scheduled waste disposal facility are exempted from the calculation of the contribution payable under section 88 of the Act for each tonne of that waste received at the waste facility— a) any spoil generated by dredging activities, b) any waste— I. collected in accordance with a community service or activity, or arising from a biological outbreak or natural disaster, and II. approved by the EPA in writing for the purposes of this clause.
EPA Role	EPA NSW responsible for waste management. Work alongside NSW DPI

Disposal preference	1. Burial on site or Landfill off site. The latter is preferable but the former (burial) is likely to happen) 2. Render 3. Landfill 4. Burning on site if manage virus and pollutants 5. Compost on or off site last on the list as there is a lack of science/evidence re pathogen survival and adequate management Primesafe note has Landfill off site as next preference to burial on site
On site Burial requirements	*Animal carcass disposal December 2017, Primefact 1616, first edition, Animal Biosecurity, NSW DPI.* Covers, Location, construction, management, disease specifics (not ASF) and transport To reduce environmental impacts, an on-farm burial site should be set up as follows: • On elevated land with a slope of less than 5% • At least two metres between the water table and the base of the pit • At least 200 metres from any surface waters (rivers, creeks, dams etc.) • At least 300 metres from neighbouring houses, buildings or public areas • On heavier soil of low permeability and good stability • A safe distance from underground and aboveground infrastructure (e.g. powerlines, telephone line, gas line, water pipes, sewerage) • Well away from the view of the general public <u>Construction of burial pit</u> The preferred equipment for constructing of burial pits is an excavator. Pit construction should only be undertaken by persons trained and licensed to operate the required machinery. At no time during or after the construction of the pit should people enter the pit. The preferred method of digging a pit is to construct a deep, narrow, vertically sided pit (trench burial). The pit must be deep enough to allow the carcasses to be covered with at least two metres of soil. The cover soil can be slightly mounded after backfilling. Suggested dimensions for constructing on-site burial pits are four to five meters in depth which results in three meters of carcass depth and the two required meters of soil cover (Figure 1). The pit should be no greater than three meters wide which helps create an even spread of carcasses in the pit. The length of the burial pit will be determined by the number of carcasses requiring disposal. Depending on the cause of livestock death and the number of carcasses to be disposed of, the pit may be required to be lined to prevent seepage of contaminated fluid into the soil and ground water. Contact information for the NSW Environment Protection Authority can be found at the NSW EPA website. Before placing ruminants into a burial pit the rumen must be punctured to prevent gas build up causing the carcass to rise up out of the pit. While doing this care must be taken to prevent spillage of body fluids. After the pit is closed the area should fenced off to reduce exposure of other stock to the area and to help in the quick rehabilitation of the site. The site should also be continually monitored for leakage of fluid that may need to be treated. https:// www.dpi.nsw.gov.au /climate – and - emergencies /emergency/ management/ resources – and – publications has a wide range of resources targeted at involved agencies including:

	• Task risk assessment for animal destruction and disposal activities in emergencies • Animal-biosecurity-pig-field-investigation-questionnaire • Risk-assessment-use-of-firearms-in-emergencies • Swms-destruction-of-animals-using-carbon-dioxide NSW
On site Composting requirements	*Procedure – Disposal of large animals by composting NSW DPI, Sept 2008* Procedure includes resources/equipment, warnings, preparation, construction, management, post compost management The following is an extract and not the full detail: Composting is undertaken in an open paddock/field – this approach requires: • Control of run-on and run-off from rainfall; • Considerations of the water table depending on soil type etc; • Management of potential pests e.g. birds, insects, foxes & feral pigs; • Use of plant/heavy machinery to construct and manage the compost. This procedure does not describe the end use of the compost post the composting cycle. The compost should be “disposed” of in a suitable area after the following considerations: • Isolation from similar enterprise farms; • Isolation from dwellings and other areas frequent by people; • Run off to dams, water ways etc. • End use of crops/pasture • Requirement to further process or remove large bones The end product can be held for an extended period in a stockpile and can be treated as noncontaminated. The composting process will reach temperatures high enough to kill FMD virus. The actual composting process will also degrade viruses and bacteria. There is a possibility that the community may see a risk associated with composting. The community and neighbours in particular should be kept informed of the on site actions. Organic matter – approximately a third by weight of the total weight of the animals to be composted or approximately 9-10m3 for each large carcass (450-500kg). Options include mulched green waste, silage and used chicken litter. Wood chips can be used but the composting process may be slower than material with pre-existing micro-organisms. Coarse material such as hay should be ground (to maximum 5cm length) and combined with manure/litter to reduce compost times and increase initial temperatures. <u>5. Procedure</u> 5.1 Preparation Collect information on: • Number, age and weight of animals • Availability of organic material on farm • Availability of organic material from other local sources • Available plant and operators on site • Dimensions of proposed composting area to determine length and number of • windrows

Develop plan of operation – including risk assessments and site map.

Site selection requires protection of water resources, property, public view and reduction of disease risk, requiring a site that is:

- Accessible by large trucks for organic material and carcass delivery
- Well drained location not subject to runoff or pooled water, and outside the 100 year
- floodplains or wetlands
- At least 200m from homes, public roads, or other areas frequented by the public
- At least 60m from water sources (e.g. wells, streams) or visible bed rock outcrops
- Away from timbered areas or buildings that could harbour rodents and burrowing
- predators.

Consideration to be given to bunding the area to arrest potential run-off and run-on to the area

<u>Construction 5.2- windrow width and height</u>

Smaller animals (e.g. calves, sows, pigs) – Figure 2

Construct windrows with layers of organic matter and 1 layer of carcasses:

- Organic material as base – 5-6m wide and minimum depth of 60cm
- Layer carcasses to maximum depth of approx. 1m i.e. 2-3 carcasses
- Place 10-15cm of organic matter between carcasses in the same layer
- Place 15-25cm of organic matter between layers
- Deep final layer of organic material covering carcasses – at least 1.2m in centre and 0.5m along the sides
- Optional layer of soil (300-500mm) can be used to protect windrow
- Completed windrow should be approximately 5-6m wide and no more than 2.6m high

Single carcasses or a few small carcasses

•Construct windrows as above with a minimum pile width of approx. 3m to provide sufficient pile volume to retain heat during cold weather

NOTE

A. Construction of layers will require careful operation of the plant.

B. No part of the carcass or contaminated material (e.g. manure) should be exposed when the windrow is complete.

5.<u>3 Construction – windrow length & spacing</u>

Allow approx. 2.5m for a maximum of 1 tonne of carcasses, i.e.

- 2 x full-sized cattle carcasses (450-500kg each), or
- 4 x 225-250kg sows or calves, or
- 8 x 110kg pigs

NOTE: Every 100m of windrow will accommodate 40 pairs of 450kg carcasses

Leave at least 2-3 loader lengths (i.e. 15-20m) between adjacent windrows to facilitate pile maintenance and construction

- Loader length is length of loader from tip of bucket to rear of loader

	Consider splitting long windrows to multiple shorter windrows to facilitate pest control and aid pile maintenance. Length may be restricted by current fences or other obstacles. 5.4 Management of composting process Dataloggers • Insert a minimum of 1 datalogger in every windrow positioned below carcass level • along the centre line. • It is preferably to have 3 dataloggers per windrow – 1 in the middle and 1 at both ends. • Ensure the locations are clearly marked. • Use of a conduit is recommended. • Dataloggers should be checked at regular intervals. The ideal compost temperature is dependent on the infective organism. • Typically the compost temperature will be approximately 55°C in about 5-9 days and climb to around 70°C in about 10-14 days however this will depend on organic material used (FMD is killed at 56°C after 30 minutes). • If the temperature does not reach the required level, contact the LDCC. • The windrow should not be mixed unless required to rectify a poorly composting windrow. • Manage pests by baiting, fencing, trapping, covering or other means as deemed necessary. • Restrict access to windrow area – erect signs and construct temporary fencing (if necessary) with gate to allow access for monitoring. • Apply organic material to cover carcasses that may be exposed due to windrow collapse, • adverse weather, or predator/pest interference. Organic material may also be used to soak up visible leachate from carcasses. Composting is considered complete when: • Temperature has reached the required level for the necessary time to kill the target • pathogen, and • Breakdown of carcasses is 80-90% complete, i.e. no soft tissues NOTE: Topsoil under windrows may accumulate salts or other phytotoxic materials that may suppress crop/pasture growth. Tillage of these soils may break up the affected layer which can then be mixed with uncontaminated soil. 5.5 Post compost management Estimated time for decomposition of large carcasses to skeletal remains is 4-10 months depending on external air temperatures, moisture content of composting pile and size of the carcasses. Large bones (of cattle particularly) and possibly wool will remain in the compost for longer periods.
On site burning requirements	*Animal carcass disposal December 2017, Primefact 1616, first edition, Animal Biosecurity, NSW DPI.* Before cremating carcasses on-site, your local fire brigade should be contacted in regard to local weather conditions, required permits and possible fire bans in your area. For more information on cremation please refer to the AUSVETPLAN Operational Procedures Manual for disposal.
AD	No Guidance

Effluent and Manure Management **Decontamination**	No guidance-possibility to give licence to pollute waters but will be on a case by case basis i.e. how much chemical is used and what type is used. This will determine how to deal with it, how to detox and store.

WESTERN AUSTRALIA

Western Australia	
Environmental legislation and guidelines	• *Environment Protection Act 1986* • *Environmental Protection Regulations 1987* • WA Ruminant and Pig Disposal Plan in the event of an EAD Version 6 18 January 2017- Internal doc only • DPIRD Livestock carcase disposal after fire, flood or drought https://www.agric.wa.gov.au/emergency-response/livestock-carcase-disposal-after-fire-flood-or-drought not for carcase disposal of diseased animals but referenced in WA disposal plan for EAD • DPIRD SOP- Disposal of carcasses in an EAD event using on site trench burial- internal doc 2017 • DAF EAD SOP Mass Burial of Animal Carcases and other Materials in an Emergency Incident- Internal Document • DAF EAD SOP Assessment of land for disposal of carcasses using on-site trench burial- 2016 – internal doc • EAD list of putrescible landfills – internal doc • Matrix of all disposal options and resources-internal doc • DAF EAD SOP Application for exemptions under section 75 of the Environmental Protection Act 1986 (EP Act), 2026- internal doc • Incident appreciation process (draft) Vic
Environmental Authorizations	Yes *Environment Protection Act 1986* **Part V Environmental regulation, Division 5 Miscellaneous** **S 75. Discharges or emissions in emergencies** (1) The CEO may, if there is, or is about to be, an emission from any premises for the purposes of — a) meeting a temporary emergency; or Environmental Protection Act 1986 b) the temporary relief of a public nuisance or community hardship resulting from the commissioning of any item of fuel-burning equipment or industrial plant, on his own initiative or at the instance of another person exempt he occupier of those premises from compliance with this Part for such period not exceeding 14 days, and subject to such conditions, as he specifies in that exemption.
Waste Levy Exemptions	Yes *Environmental Protection Regulations 1987* Exemptions from this Part; refunds etc. of levy (1) A licensee may by application in the approved form claim an exemption from regulation 22 for the following waste received at a licensed landfill in any return period c) approved waste that has been disposed of in an approved manner. (3) The Chief Executive Officer may, by written notice — a) grant, or refuse to grant, an exemption; or b) grant an exemption subject to conditions, or limited to circumstances, specified in the notice; or c) revoke an exemption. d)
EPA Role	Waste Management. Identifying on and offsite locations Work alongside DPIRD Pre-approval for disposal sites incorporated into licence List of landfills categorised on size available

Disposal preference	Based on guidance-internal doc 1. Burial on farm or Compost on farm 2. Local government composting or render 3. Landfill off site 4. Burial in greenfield site A decision tree (Section 5 of internal doc) will be used to guide decisions on the most appropriate of the four broad disposal options.
On site Burial requirements	*DPIRD Livestock carcase disposal after fire, flood or drought* https://www.agric.wa.gov.au/emergency-response/livestock-carcase-disposal-after-fire-flood-or-drought - not for carcase disposal of diseased animals but referenced in WA disposal plan for EAD If burying livestock carcases on your farm, there is no limit to the weight or volume of carcases that can be buried. The burial must avoid any environmental emissions. Any smell (gases) will be minimised if pit construction guidelines (as below) are followed. Liquid leaking into the environment will be avoided by selecting a site with impermeable soils. • must not be within 10 kilometres (km) of a town water supply intake or within 300 metres (m) of a borehole used for drinking water • must be more than 2km from a town and 1km from any dwelling • should be on soils of low permeability; clay is ideal • should have groundwater at the site more than 10m below the base of the burial pits at all times • should be more than 100m from any watercourse • should be more than 400m from any lake and 100m from any wetland • will be more than 2km from the coast • will not be within 1km of a World Heritage Area • will not be within 250m of a national park or conservation area • should be accessible to large trucks and earthmoving equipment, allowing them to enter easily and be effectively disinfected • should not be on a slope greater than 6% and allow digging of 5m deep pits with heavy equipment. It is advisable to record the GPS coordinates of the site for future land-use planning. Provides Pit dimension Dimensions required: • 1.5 cubic metres (m3) per cow • 0.3m3 per pig or sheep • minimum depth of pit is 5m • required depth of soil to cover carcases is 2m. A pit 3m wide at the base, 5m wide at the top of the carcases, and 5m deep, filled with carcases to within 2m of ground level (Figure 1) has an effective available volume of 12m3 for every linear metre. Using these dimensions, for each linear metre of trench, 8 cattle or 40 sheep can be buried.

WA Ruminant and Pig Disposal Plan in the event of an EAD, Version 6 ,18 January 2017 Internal doc only

On-farm burial of animals owned by the landholder of the land where the carcases are to be buried is legal under the Environmental Protection Act 1986 (EPA) with no permit required for such burial. However, DAFWA is responsible for any environmental issues (causing an emission) in the short or long term. This makes the assessment of the soil structure where trenches are to be dug critical to managing any risks which may ensure from the disposal. The assessment of the location and soil profile must be carried out as outlined in the SOP

On- farm – assessment of site location, suitable soil type and capacity of area of suitable soil type. An estimated 4,800 cattle or 24,000 sheep can be buried by trench burial per Ha of suitable land

It is highly unlikely that properties of less than 100 Ha would meet the suitability criteria.

Off-site burial
WA disposal plan identified four of the largest sites licenced by DWER to dispose of putrescible waste and their annual disposal license limits are:

- Cleanaway Banksia Rd (Dardanup) Landfill L8904- Licensed to bury 300,000 t/pa.
- Suez, North Bannister Landfill L8871- Licensed to bury 350,000t/pa and a composting facility licensed to produce 33,000t/pa of compost.

- City of Rockingham Miller Rd Landfill, Rockingham-Licensed to bury 450,000t/pa
- EMRC Redhill landfill, Gidgegannup- Licensed to bury 350,000t/pa and produce compost 50,000t/pa

Burial in green-fields constructed site on crown land managed by contractors under emergency arrangements.

Two suitable sites at Badgingarra and Newdegate have been identified which could support the burial of the number of carcases identified in the worst case scenario

Given these risks, delays and the cost of developing such a site from scratch, this option should only be used as a last resort. *DPIRD SOP- Disposal of carcasses in an EAD event using on site trench burial*

Trench design and capacity guidelines are detailed in AUSVETPLAN Operational Manual- Disposal. Engineers and earth moving contractors may need to be involved in the design of the trenches.

- Located in soil type of low permeability (avoid highly permeable sands, gravels, substrata, Karst geology)
- Not located in areas subject to instability i.e. susceptible to landslip or excessive erosion, geological fault* Different to guidance above
- Not located in a flood prone area i.e. > 1 in 100 years flood level * Different to guidance above
- Located at least 200m from surface waters and groundwater supply bores. * Different to guidance above surface water and bore
- Located at least 300m from a dwelling (sensitive use) * Different to guidance above
- At least 2m separation from bottom of proposed pit to groundwater level * Different to guidance above
- Preferably on elevated land with moderate slope (less than 5%)* Different to guidance above
- Located safe working distance from underground infrastructure (power, telephone, gas, water, sewerage) * Different to guidance above
- Located away from public view* Different to guidance above
- Complementary to native flora and fauna planning controls i.e. significant wetlands, tidal areas, wildlife habitats* Different to guidance above
- Complementary to heritage overlays, native title and other covenants* Different to guidance above
- Complementary to any other regulatory requirements* Different to guidance above

DAF SOP Mass Burial of Animal Carcases and other Materials in an Emergency Incident- Internal Document

Factors for consideration

- Located in soil types of low permeability (avoid highly permeable sands, gravels, substrata, permeable rock e.g. limestone)
- Not located in areas subject to instability i.e. susceptible to landslip or excessive erosion, geological fault
- Not located in a flood prone area i.e. > 1 in 100 years flood level
- Not established or extended into a drinking water catchment area. *Different to guidance above
- Not located in areas where the surrounding land use is incompatible with the purpose and nature of the facility *Different to guidance above
- Located at least 200m from surface waters and groundwater supply bores
- Located at least 500m from a dwelling (sensitive use) *Different to guidance above
- Located at least 1500 m from an aerodrome for piston-engineered propeller-driven aircraft or 3000 m from aerodrome for jet aircraft *Different to guidance above
- At least 2m separation from bottom of proposed pit to historic groundwater level *Different to guidance above
- Preferably on elevated land with moderate slope (less than 5%)
- Complimentary to native flora and fauna planning controls i.e. significant wetlands, tidal areas, wildlife habitats
- Complimentary to heritage overlays, native title and other covenants
- Complimentary to any other regulatory requirements
- Located away from public view
- Located safe working distance from underground infrastructure (power, telephone, gas, water, sewerage)
- Good road access to site with minimal effects on traffic
- Undesirable where topographic features are likely to cause higher than average rainfall*Different to guidance above
- Desirable where higher sunshine area/north facing slope to reduce infiltration through increased evaporation rate*Different to guidance above
- Desirable to have natural shelter from winds to reduce odour nuisance*Different to guidance above

Where additional containment standards are required i.e. synthetic liners, the following considerations should be incorporated:

Mass burial facility would be considered equivalent to a Class II Landfill (Licensed to accept putrescible waste)

However, sophisticated the engineering components of the facility, this must be regarded as a secondary containment system which supplements the natural containment of contaminants afforded by site topography and subsurface conditions.

DAF SOP Assessment of land for disposal of carcasses using on-site trench burial

Preferred sites

- Areas free of exposed granitic rocks (shallow depth, waterlogging, recharge.
- Elevated locations on erosional lateritic surfaces (deep soils of low permeability)
- Convex landforms, no drainage lines (prevention of erosion and waterlogging)
- Near remnant vegetation (dry soils, erosion protection, soil biologic activity)
- Remote from housing (own, neighbours)
- Remote from water supplies (dams, bores, soaks), creeks, saline areas
- Proximity to tracks and laneways (access)

Environmental Criteria

- Not located in areas subject to instability i.e. susceptible to landslip or excessive erosion, geological fault

	- Not located in a flood prone area i.e. > 1 in 100 years flood level - Located at least 200m from surface waters and groundwater supply bores - Located at least 300m from a dwelling (sensitive use) - At least 2m separation from bottom of proposed pit to groundwater level - Preferably on elevated land with moderate slope (less than 5%) - Located safe working distance from underground infrastructure (power, telephone, gas, water, sewerage) - Located away from public view Topsoil assessment - Using available mapping or local knowledge, locate test sites in areas of gravelly and loamy soils in upper 30% of landscape where expected subsoil depth is minimum of 5m Subsoils assessment - The ideal profile is white sandy clays to a depth of target (plus 1m) - Use excavator or drilling machine to penetrate to depth of 5m - Drill at least 5 sites, corners and centre of proposed pit - Sample at 1m increments and check for colour, texture – clay dominant, and lack of sand/rock. White to orange sandy clays reflects suitable clay content. - Texture soils into ribbons of at least 5cm using methodology described (Research Library RMTR 380) ENVIRONMENTAL CRITERIA - Located in soil type of low permeability (avoid highly permeable sands, gravels, substrata, Karst geology) - Not located in areas subject to instability i.e. susceptible to landslip or excessive erosion, geological fault - Not located in a flood prone area i.e. > 1 in 100 years flood level - Located at least 200m from surface waters and groundwater supply bores - Located at least 300m from a dwelling (sensitive use) - At least 2m separation from bottom of proposed pit to groundwater level - Preferably on elevated land with moderate slope (less than 5%) - Located safe working distance from underground infrastructure (power, telephone, gas, water, sewerage) - Located away from public view - Complementary to native flora and fauna planning controls i.e. significant wetlands, tidal areas, wildlife habitats - Complementary to heritage overlays, native title and other covenants - Complementary to any other regulatory requirements *EAD list of putrescible landfills- internal doc*
On site Composting requirements	*Livestock carcase disposal after fire, flood or drought*https://www.agric.wa.gov.au/emergency-response/livestock-carcase-disposal-after-fire-flood-or-drought - not for carcase disposal of diseased animals but referenced in WA disposal plan for EAD Composting is the natural aerobic decomposition of carcases. This disposal method will require expertise with composting animal carcases or the input of a composting contractor.

	Provides no specific operational requirements *WA Ruminant and Pig Disposal Plan in the event of an EAD, Version 6 ,18 January 2017 Internal doc only* When considering composting, if less than 20 pigs and not for ruminant carcases are to be disposed of and a contractor with experience in composting pigs is available then the composting should be considered as a viable option. Local Government offered disposal options (e.g. composting, rendering) in sites offered as options by. The 20 highest risk LGAs in the state have supplied a list of potential disposal options in their area. There options will be, risk assessed to determine their capacity and suitability in the particular incident.
On site burning requirements	No burning guidance
AD	No AD guidance
Effluent and Manure Management **Decontamination**	No Guidance on decontamination

SOUTH AUSTRALIA

	South Australia
Environmental legislation and guidelines	• *Environment Protection Act 1993* • Compost guideline, EPA SA June 2019 • On-farm disposal of animal carcasses Updated February 20161 EPA 682/16: *This information sheet explains how to dispose of animal carcasses on farms, and does not apply for carcasses from intensive livestock operations such as poultry (broiler or egg) farms, piggeries, cattle and sheep feedlots.*
Environmental Authorizations	Yes *Environment Protection Act 1993* **Part 12—Emergency authorizations** **S 105—Emergency authorizations** (1) The Authority or an authorized officer may issue an authorization in writing to a person authorizing an act or omission that might otherwise constitute a contravention of this Act if the Authority or authorized officer is satisfied— a) that circumstances of urgency exist such that it is not practicable for the person to obtain an exemption; and b) that authorization of the act or omission is justified by the need to protect life, the environment or property. **Part 6—Environmental authorizations and development authorizations** **Division 3—Exemptions** **S 37—Exemptions** Subject to this Act, a person may obtain an environmental authorization in the form of an exemption exempting the person from the application of a specified provision of this Act in respect of a specified activity.
Waste Levy Exemptions	Yes *Environment Protection Act 1993* **Miscellaneous—Part 15 116—Waiver or refund of fees and levies and payment by instalments** The Authority or another administering agency may, in cases of a kind approved by the Minister— a) waive the payment of, or refund, the whole or part of a fee or levy otherwise required to be paid to the Authority or other administering agency under this Act; or b) allow the payment of a fee or levy by instalments. No mention of emergency in SA act EPA would provide a case in kind to the Minister.
EPA Role	Referral agency under the State emergency committee responsible to waste management Main role PIRSA Biosecurity

Disposal preference	1. Preference is to a licenced EPA facility which is permitted to receive carcasses (or engineered facility) Some are not licenced/ normally suitable to receive they can issue an emergency authorization. Compost or renderer preferred over a landfill in accordance with waste hierarchy 2. On site disposal guided by AusVet Plan
On site Burial requirements	PIRSA Case by Case situation General provisions of the act are not pollute waterways etc. Take into consideration groundwater, neighbours etc Have undertaken land profiling to identify suitable sites. Prefer on farm to have identified sites. *On-farm disposal of animal carcasses, EPA 2016* Selecting a shallow, trench burial or composting disposal site • Soils with clay subsoil are most suitable for burial trenches or composting areas. Soils with high leaching properties • (sand, gravelly or rocky soils) are to be avoided where possible. • Disposal sites should be at least 250 m from defined depressions, watercourses and surface water catchments (such • as streams, rivers, creek beds and wetlands). • The base of the trench should be at least 2 m above the water table. • The site should be at least 250 m from the nearest bore and neighbouring residential building. When digging burial trenches the following factors should also be taken into consideration: • For safety reasons, people should not work in trenches over 1.5 m deep unless the sides are battered (slope of 2:1) • or shored up. • The site should be free of underground services (pipelines, power and telephone lines) and should not interfere with • access to roads. • The site should be accessible to earthmoving plant, stock and operators. Soils must be stable enough to take the • weight of equipment used to construct and fill trenches. • Rather than opening abdomens, surplus soil should also be heaped over the trenches to allow for subsidence. • Disposal trenches should be inspected regularly during the months after closure to check for subsidence and • seepage. Please contact the EPA for advice only if seepage occurs.
On site Composting requirements	On-farm disposal of animal carcasses, EPA 2016 Selecting a shallow, trench burial or composting disposal site as outlined in the burial section above Will need to meet the requirements of a normal licenced composting facility. Schedule 1 EP Act SA 1993 (2) Waste reprocessing the conduct of— (a) composting works, being a depot, facility or works with the capacity to treat, during a 12 month period— (i) in the case of works located wholly or partly within a water protection area—more than 200 tonnes of organic waste or matter; or (ii) in the case of works located wholly outside of a water protection area—more than 1 000 tonnes of organic waste or matter, for the production of compost; or ***Compost guideline, EPA SA June 2019***

The conduct of composting works is a prescribed activity of environmental significance for the purposes of clause 3(2)(a) of Schedule 1 of the Environment Protection Act 1993 (the EP Act). Composting works that produce, or are capable of producing in excess of 200 tonne of mushroom or other compost per annum require a licence in accordance with section 36 of the Act. Note: under an emergency situation an emergency authorization would be sought.

Sets out objectives and minimum expectations. Objectives listed below. A number of minimum expectations listed where required.

This guideline has been developed to advise industry on how the EPA will seek to apply section 25 and mandatory provisions of environmental protection policies, in particular:

- section 25 – general environmental duty− which imposes a general environmental duty on all persons undertaking an activity that may pollute to take all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

<u>Siting of compost works</u>

Composting facilities should be located so as to reduce the potential risks of adverse environmental impacts
and offsite nuisance impacts.

The EPA recommends that the operation of composting facilities is avoided in the following locations:

- 1,000 m to land that is for sensitive use
- Within the floodplain known as the '1956 River Murray Floodplain' or any floodplain subject to flooding that occurs, on
- average, more than one in every 100 years
- Within the Mount Lofty Ranges Water Protection Area and the South East Water Protection Area as declared under Part 8 of the EP Act
- Within 100 m of a bank of a major watercourse (e.g. Murray, Torrens and Onkaparinga Rivers), or within 500 m of a
- high-water mark
- The separation distance should be measured from the boundary of the composting activity (including the wastewater
- lagoon) at the site to the nearest receptor
-

<u>Windrow liner</u>

- Open windrow composting facilities should receive, store and process incoming feedstocks on a low permeability liner with a 2% minimum drainage gradient that directs wastewater to a leachate collection system.
- Finished compost product should be stored on a designated hardstand area that has a minimum 2% drainage gradient to direct the potentially nutrient rich runoff into a wastewater management system capable of removing the sediments and nutrients.

<u>Design of wastewater management system</u>

- Composting facilities must comply with clause 15 of the Environment Protection (Water Quality) Policy 2015.
- It is critical to design compost facilities to separate stormwater from wastewater (including leachate) management systems.

<u>Stormwater</u>

- Composting facilities should be designed to divert clean stormwater from pooling or draining towards areas where feedstocks and finished compost product are received, sorted, stored or processed.

<u>Incoming feedstocks</u>

- Category A waste-feedstocks should be incorporated into the windrow upon receipt at the compost site, (or if not practicable, within 48 hours of receipt)
- Liquid wastes Category A Feedstock should be received in a concrete bund, blended with suitable binding agents and incorporated into the compost windrow within 24 hours of receipt.

Quality assurance
Product quality assurance should be implemented to ensure that the composting processes are fit for purpose for the site's proposed use.

- Where compost windrows contain manure, animal waste, food or grease trap waste and biosolids and/or their sludges, the whole mass of the windrow should be subject to a minimum of five turns and the core temperature maintained in excess of 550C for fifteen consecutive days following each turn to eliminate pathogens, weeds and seeds[9].

[9]This requirement is consistent with the requirement specified in section 3.2.1(a) of the Australian Standard 4454–2012 (4th edition).
Finished compost product should be tested to demonstrate compliance with the criteria specified in Table 2.

Product labelling
- Compost should be appropriately labelled to ensure that a consumer is informed about the potential
- environmental and human health risks of the compost product.

Noise
The operator of a composting facility should manage and mitigate potential off site noise impacts in accordance with the EP Act and the Environment Protection (Noise) Policy 2007 (Noise Policy).
The conduct of a composting facility should not exceed the following limits at a noise affected premise as detailed in section 5 'Indicative noise levels' of the Noise Policy.

Dust
The conduct of a composting facility should manage and mitigate offsite dust impacts so as to meet their general environmental duty as defined in section 25 of the EP Act.

Odour

The operation of a compost facility should not exceed two odour units at the boundary of the premise so as to meet their general environmental duty as defined in section 25 of the EP Act.

Vectors
Composting facilities should take all reasonable and practicable measures to prevent the attraction and harbourage of vermin so as to meet their general environmental duty as defined under section 25 of the EP Act.

Litter
Composting facilities should take all reasonable and practicable measures to prevent litter escaping the premise and collect any litter that escapes from the premise on or before the close of each day's operation so as to meet their general environmental duty as defined under section 25 of the EP Act.

Records maintenance including environmental management plan
Composting facilities should maintain records relating to site activities that are capable of being audited and demonstrate compliance with all relevant sections of the EP Act, policies and guidelines so as to meet their general environmental duty as detailed under section 25.

	PIRSA PIRSA Case by Case situation General provisions of the act i.e. not pollute waterways etc. Take into consideration groundwater, neighbours etc Have undertaken land profiling to identify suitable sites. Prefer individual farm to have identified sites.
On site burning requirements	PIRSA Case by Case situation General provisions of the act i.e. not pollute waterways etc. Take into consideration groundwater, neighbours etc Have undertaken land profiling to identify suitable sites. Prefer on farm to have identified sites.
AD	No AD guidance
Effluent and Manure Management Decontamination	Effluent system decontamination- must meet general environmental duty

TASMANIA

Tasmania	
Environmental legislation and guidelines	• *Environmental Management and Pollution Control Act 1994* • Environmental Management and Pollution Control (Waste Management) Regulations 2020 • Emergency Burial of Carcasses- bushfires
Environmental Authorizations	*Environmental Management and Pollution Control Act 1994* **Division 5 - Emergency authorizations** **34. Emergency authorizations** (1) The Director or an authorized officer may issue an authorization in writing to a person authorizing an act or omission that might otherwise constitute a contravention of this Act if the Director or authorized officer is satisfied – a) that circumstances of urgency exist; and b) that authorization of the act or omission is justified by the need to protect life, the environment or property. (2) An authorization under this section may be issued subject to such conditions as the Director or authorized officer considers appropriate and specifies in the authorization. (3) A person does not incur criminal liability in respect of an act or omission authorized under this section.
Waste Levy Exemptions	No- currently no waste levy applied. May come into effect 2021. Landfills do charge however and if dead pigs were sent to a landfill, they may be able to negotiate the fee Same for any organised composting or waste facility
EPA Role	Waste Management working alongside Biosecurity Tasmania EPA ability to instigate section 34 of the Act to issue an emergency authorization No legislative restrictions on what can do-each site and situation different and need to adapt. Need to follow general environmental duties
Disposal preference	EPA mentioned on site likely preferred Biosecurity Tasmania Offsite facility preferred 1. Burial on site if allowed 2. Burial offsite to landfill 3. Burning Offsite Compost on and offsite not a preference- lack of confidence in systems management and monitoring i.e. required temp to achieve destruction of virus in ASF case.
On site Burial requirements	No set guidelines. Assessed on a case by case basis. Would need buffers to waterways etc AusVet Plan would be used as a base. Bushfire Burial Guidelines could be used as a base. *Emergency Burial of Carcasses*

	Carcasses burial must only occur with consent of the land owner. Records should be kept by the land owner of all burial pit locations and the quantity of material that has been buried at each location. Please give careful consideration to the location of the burial pits to prevent any contamination of surface or ground waters and subsequent risk to human and animal health and to the environment. • Burial sites must not contain more than 20 tonnes of carcasses in a single pit as there is a risk of generating large quantities of leachate. • Ideal sites for carcass burial will have the following characteristics • Deep clay textured soils • Ground water table separation distance from the bottom of the pit of at least 2 metres • Slope less than 10% A location that complies with the following buffer distances (try to comply with these buffer distances if it at all possible): • Watercourse and dams 100m • Residence and sensitive areas 1000m • Property boundary 20m • Drinking water bore 250m Sawdust can be added to the bottom of pits to reduce risk of leachate generation. It is not recommended that lime be added to pits unless there is a biosecurity reason for doing so as this will reduce the decomposition rate of the carcasses. Surface drainage should be directed away from the pit location by setting up diversion drains up slope of the pit location. When full the pit must be covered with a minimum of 1 m depth of soil. The soil should be mounded over the pit to prevent rain collecting in the pit. The pit cover will subside as the carcasses break down.
On site Composting requirements	No set guidelines. Assessed on a case by case basis. Would need buffers to waterways etc Meet General Environmental duties
On site burning requirements	No set guidelines. Assessed on a case by case basis. Would need buffers to waterways etc Meet general environmental duties
AD	No AD guidance
Effluent and Manure Management **Decontamination**	Remediation of land- no guidance May need to enact animal health act and biosecurity act. Animal health Act allows a direction to be put on property and they may require pigs not be on a site for X timeframe. Might be more necessary for an outdoor piggery in which it may be more difficult to decontaminate a paddock.