Final report

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Feasibility of using alternative storm water treatment technologies & new innovative policy, for sustainably managing contaminated storm water run-off

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1 Introduction

A Red Meat Processor (the company) engaged a consulting service provider (the consultant) to undertake a review of the key stormwater management issues at one of the company's meat processing facilities and to identify potential stormwater management improvements for consideration.

The stormwater management options identified and investigated in this report for their potential to deliver upon regulatory obligations include:

- avoidance of stormwater runoff by roofing
- storage in, and evaporation from, Contaminated Stormwater Pond (CSP's)
- capture in CSPs and transfer to evaporation ponds for evaporation
- wetland treatment; and
- land-based re-use through irrigation

The company also sought advice in relation to the Queensland Government 'Flexible options for managing point source water emissions: A voluntary market-based mechanism for nutrient management' Policy and its potential application to the alternative stormwater management solutions.

The environmental licence regulator (Department of Environment and Heritage Protection's - DEHP) hierarchy of methods for dealing with stormwater, which includes (from most preferred to least preferred):

1. Avoid the contamination of stormwater in the first place, for example by roofing areas where contaminants and or wastes are stored or handled, diverting uncontaminated stormwater run-off away from areas where contaminants or wastes are stored or handled, by preventing the contact of incident rainfall with contaminants or wastes and utilising alternate materials and or processes.
2. Minimise the quantity and or hazardous nature of the contaminated stormwater generated, for example by minimising the size of area where contaminants or wastes are stored or handled and by utilising alternate materials and or processes.
3. Recycling of contaminated stormwater generated, for example by incorporating reuse, reprocessing and utilisation of the stormwater for a worthwhile purpose
4. Treatment of any contaminated stormwater to render it less or non-hazardous.
5. Release of contaminated stormwater as a last resort (outside of the design parameter of 1 in 20 year, 24 hour storm event).

2 Methodology

2.1 Literature Review

To establish both the regulatory framework and industry standards for the treatment of stormwater runoff from an abattoir in Australia a review of relevant literature was conducted as well as review of Environmental Licence and Regulations, State and National guidelines and a range of other technical documents pertinent to stormwater quality standards.

2.2 Site Inspection

- The company hosted a site inspection of industry specialists in order to understand what options would physically be available to them to consider

3 Results

3.1 Literature Review Outcomes

The information identified in the literature review has been used to identify relevant stormwater management issues and potential solutions.

3.1.1 Stormwater discharge standards

The company's environmental licence defines stormwater management standards with the key overarching requirement being *that all practicable measures be taken to prevent and/or minimise the release or likelihood of release of contaminated runoff to any drain or waters or the bed or banks of any such waters*. Furthermore, "*the appropriate design standard for any stormwater management systems and processes is a 1 in 20-year, 24 hour storm event*".

These conditions are consistent with state and national guidelines for contaminated stormwater from cattle feedlots being contained on site and evaporated or reused.

3.1.2 Wetlands

Constructed wetlands treatment systems are engineered systems to utilise the natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist in treating wastewater. They are designed to take advantage of many of the same processes that occur in natural wetlands, but do so within a more controlled environment. Some of these systems have been designed and operated with the sole purpose of treating wastewater, while others have been implemented with multiple-use objectives in mind, such as using treated wastewater effluent as a water source for the creation and restoration of wetland habitat for wildlife use and environmental enhancement

In 1993, the USEPA (EPA 1993) performed a case study of 17 constructed wetlands for managing wastewater treatment. In most cases, constructed wetlands met treatment performance expectations, often achieving greater than 90% removal of nutrients. The case study identified that whilst improving water quality was the main objective of the wetlands, additional environmental benefits were realised through wildlife habitat generation.

Constructed wetlands are on possible option for treating livestock wastes and removing nutrients when used in combination with some form of pre-treatment. Due to the ammonia concentration in cattle yard and/or feedlot runoff and associated toxicity with plant life, wetlands would be more suited to polishing system for cattle yard and/or feedlot runoff.

The two types of constructed wetlands used today are free water surface and submerged flow wetlands. Free water surface wetlands pass influent over and through wetland plant material. Submerged flow wetlands act as an infiltration area for wastewater. The influent passes through soil eliminated surface flow water out of the wetland. Submerged flow wetlands are typically deeper than that of free water surface wetlands and are made up of various sizes of gravel, crushed rock and soil.

In a review by Woerner & Lorimor (2006) it was reported that removal rates varied from 60-99% for BOD, 43-97% for Nitrogen and 28-99% for Phosphorous. This leaves operators open to risk of non-compliance and potential enforcement action.

There is considerable evidence in the literature that wetlands can achieve high standards of stormwater management from agricultural land uses. Accordingly, wetlands have the potential to satisfy Method 4 of the hierarchy of methods for dealing with contaminated stormwater: "*treatment of any contaminated stormwater to render it less or non-hazardous*". However, wetland modelling would need to show a reduction in pollutant levels approaching that of a no-release scenario for the 20 year 24 hour storm.

If Environmental Regulators are open to the idea of licencing alternative treatment technologies for managing contaminated streams, then a wetland treatment system may be applicable to sites with available land and right circumstances for adoption.

However, the literature support the proposition that properly design and managed treatment and release system can provide equal surface water protection and total containment.

4 Alternative solutions considered

The alternative solutions considered are outlined below. The requirements of each alternative solution is discussed in the following sections. Indicative costs have also been included. These costs are high level costs and should be used purely as a guide and not for purposes of tender.

4.1 Option 1: Avoidance of stormwater runoff by roofing

The National Guidelines for Beef Cattle Feedlots in Australia (2012) and the environmental licence identify a hierarchy of controls for the management of contaminated stormwater runoff. The highest priority is given to exclusion of the holding pen ground area from the catchment by roofing. Should the holding pens be roofed and bunded sufficiently, no further action would be required as the contaminants would not enter the stormwater system.

Roofing requires a moderately high capital cost, but very little ongoing maintenance and management costs. Moreover, roofing has other potential benefits beyond stormwater management that might assist in justifying the capital costs, including in relation to cattle condition and (potentially) generating high quality rainwater.

4.2 Option 2 – Evaporation from Contaminated Stormwater Ponds

In order to operate the CSPs as both holding ponds and evaporation basins, the capacity of the CSPs would need to be increased significantly. The current ponds do not have capacity to contain the 20 year, 24 hour event in isolation without pumping.

Approximate sizing of the CSPs has been undertaken based on the hydrology of the abattoir site and the hydraulics of the CSPs median annual rainfall. It is noted that if the sizing is based upon the hydrology of a median rainfall year, then either freeboard contingency or capacity to pump elsewhere is required. Costs of expanding the capacity of the CSPs will reflect whether both CSPs are upgraded or whether there is partial or total diversion from one to the other the engineering works required to stabilise the CSP walls as it is deepened; and the incidence of contamination that may require specific management and disposal.

4.3 Option 3 – Irrigation from Contaminated Stormwater Pond

A potential method of stormwater disposal outlined within the development permit is disposal to land. However, due to a lack of available land suitable for irrigation, this option is not possible.

The third method identified in the hierarchy of stormwater disposal option is recycling of contaminated stormwater generated for a worthwhile purpose. Further addition of contaminated stormwater to the paddocks is likely to increase nutrient levels and may be unlikely to meet the beneficial reuse criteria. There is however, potential to plant a crop, such as Lucerne, which may absorb additional nutrients from the contaminated wastewater.

Irrigation re-use of stormwater will still require upgrading of the CSPs. Additional capital costs will include the cost of the irrigation infrastructure and ongoing management.

4.4 Option 4 - Wetlands

Constructed wetlands have been used extensively in domestic sewage treatment scenarios and may be appropriate for treatment of contaminated stormwater from holding pens. The option of a wetland was investigated to identify ways of treating runoff from the holding pens that could allow it to be released back to the environment or used for irrigation purposes.

The calculations assume that a permanent pool remains within the wetland (to allow for wetland function including plant health) which is not pumped out and the required 20 year, 24 hour storm storage volume is contained within the 'extended detention depth'. This Extended Detention Depth (EDD) is limited to 0.5m maximum in accordance with industry standards. Preliminary investigations using proxy pollutant generation data indicate that over 90 % removal of TSS, TP and TN may be achieved.

The approximate size of the wetlands required based on contaminated stormwater volumes is approximately 1.6 hectares. This represents a substantial portion of the site.

A pre-treatment system would be required for this option to remove bulk solids and settle out suspended solids from the contaminated stormwater prior to entering the vegetated zone. An inlet pond would achieve this requirement: However, these ponds would also need to be sized to contain the design 1 in 20 year, 24 hour storm.

In summary, the constraints of implementing a constructed wetland treatment system for contaminated stormwater runoff

1. High Ammonia in runoff – High Ammonia levels in holding pen runoff can impact negatively on the plant life within the wetland. As summaries in the literature review section, a wetland could be adopted at a polishing system after a primary treatment process.

2. Large Footprint – Large parcels of land will need to be available for a wetland treatment system to be installed. This will be a limiting factor for plants and feedlots with limited available land.

3. Constant Saturation – Normal wetland design treatment system are design for continuous saturation to sustain plant life. Plant located in dry areas may have difficulty in sustaining plant biomass within a wetland system.

4. Regulatory Approval – The environmental regulator would need to approve the installation of a constructed wetland treatment system with discharge licence conditions likely to be strict.

5. Compliance Risk - Discharge quality is not guaranteed from a wetland. Operators will be liable for not achieving compliance limits if performance is unsatisfactory.

A wetland treatment system may be feasible for a feedlot or processing plant with ample space with regulator support implement such a system.

4.5 Option 5 – Transfer to and evaporation from existing treatment ponds

Option 5 involves pumping water from both the CSPs into previously used wastewater treatment ponds. Pumps connecting the CSPs and the previously used wastewater treatment ponds, while in place, may need upgrading to handle volumes.

The current ponds do have capacity to contain the 20 year, 24 hour event with freeboard. A combination of one or both of upgrading capacity of the CSPs and/or installing sufficient pumping capacity to ensure compliance with the 20 year, 24 hour event requirements would be needed.

4.6 The State's Nutrient Offset Policy

The 'Flexible options for managing point source water emissions: A voluntary market-based mechanism for nutrient management' Policy ("the Policy"), provides guidance to environmental authority holders, that discharge directly to surface waters, in using alternative nutrient reduction actions to counterbalance nitrogen and phosphorous loads contained in water emissions. Alternative nutrient reduction actions may come from another point source, or may be achieved through diffuse actions such as bank stabilisation, improved fertiliser application and constructed wetlands.

The use of wetlands combined with the application of the Nutrient Offset Policy would need to pass the Department of Environment and Heritage Protection approval process to become feasible. One mayor hurdle would be for the regulator to approve a constructed wetland for point source discharge. If this was able to be achieved, the Nutrient Offset Policy would be able to be applied. A plant located next to a major river would be more suited to the application of this process.

With regards to the broader scope of industry that discharges treated wastewater directly to surface waters under a Queensland Environmental Authority, the Policy may be able to be utilised to maintain compliance with discharge limits/loadings. This policy could be applied to a plant that may increase in volume/loadings discharging from the wastewater treatment system. The discharger is able to explore opportunity to offset the nutrient loading increases that may impact on the Environmental Authority compliance limits. Under the policy, instead of the company investing in a hard engineering solution they may explore way to offset the increase in nutrients to the receiving waters within their catchment. Some examples of works that can be explored to offset additional nutrient inputs.

- riparian area restoration
- constructed wetlands
- fertiliser application management
- grazing land management practices
- water sensitive urban design

With regards to the application of wetlands, the policy refers to the use of a wetland to offset the nutrient inputs from a point source discharge (directly from a wastewater treatment plant

to a river). A constructed wetland may be able to be explored for managing a local farmers runoff prior to discharge to the local river.

This policy is still in its infancy with only one trial currently occurring at a sewage treatment plant in Beaudesert. Once the policy has been applied successfully to a number of different applications, the regulator may be more willing to apply it areas other than wastewater management. The policy provides meat processing plants with corporate social responsibility, stakeholder engagement and supply chain opportunities to partner with a local supplier to improve environmental outcomes for the catchment. The policy could also have big implications for the entire industry to create partnerships with local suppliers and landholders to achieve a more sustainable supply chain from paddock to plate.

This policy has the potential to be applied to the red meat industry; however the circumstances of its adoption will vary considerably between different plants based on circumstances to be negotiated with the QLD Department of Environment and Heritage Protection in detail.

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