DEVELOPING IRRIGATION GUIDELINES FOR WASTEWATER IRRIGATION

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ABSTRACT

New Best Practice Environmental Management Guidelines for Wastewater Irrigation have been prepared for the Victorian EPA. These have focussed on identifying clear performance outcomes that need to be met to achieve sustainable irrigation. The risks that are associated with each potential site are assessed against twelve elements that impact on that sustainability. There are five elements that relate to the wastewater (and operator), wastewater volume, nutrients, salt & sodicity, other toxicants and viability. The remaining seven relate to the protection of the environment at, or within, influence of the site. These are soil, surface water, groundwater, human & stock health, public amenity, native vegetation and cultural heritage. Practices are identified in the guidelines and change according to the risk level that exists at the site. The guidelines will have a framework for the development of an Environmental Improvement Plan (EIP); some information on the statutory support for the guidelines and a checklist of what needs to be assessed for each irrigation development.

1.0 INTRODUCTION

Developed societies have begun to realise that water is a limited and valuable resource. Our use of water needs to be improved to protect the environment. Wastewater is a key resource that can provide "beneficial use" to society when used for irrigation.

Rendell McGuckian have been working with the Victorian Environment Protection Authority (EPA) to produce the Best Practice Environmental Management Guidelines (BPEMG) for Wastewater Irrigation. This is part of a suite of BPEMG that the EPA is preparing.

The Wastewater Irrigation BPEMG is specifically about irrigation with wastewater and complements the broader Environmental Guidelines for the Use of Reclaimed Water. For irrigating with wastewater, to gain EPA approval, a proponent must be able to demonstrate that the outcomes listed in the Wastewater Irrigation BPEMG can be achieved

At the time of preparation of this paper, the BPEMG for Wastewater Irrigation was in draft form and the final document should be available soon after this conference.

Due to this timing, the details in the guidelines may change slightly. This paper is to explain how to use them when they appear. This paper is not to be used, or quoted, as the guidelines themselves.

2.0 APPROACH TO THE GUIDELINES

2.1 Outcome Focussed

A clear focus on the outcomes to be achieved by using wastewater for irrigation was the starting point in writing the guidelines. Identifying the overall objective and then defining the performance outcomes that must be in place to achieve the sustainable irrigation with wastewater were the first steps.

The overall objective when using wastewater for irrigation has been defined as the need to:

"*utilise the available wastewater as a resource that is consistent with the users business objectives and in a manner that is ecologically sustainable*".

The guidelines will set out the performance outcomes that need to be achieved for sustainable irrigation with wastewater. They will also outline practices that are appropriate for different situations (ie different risk levels).

All people considering wastewater irrigation, those managing the irrigation and those responsible for monitoring and reviewing the performances of the irrigation system will need to understand how to achieve the outcomes in the guidelines.

Wastewater can come from urban water authorities, intensive animal industries (eg piggeries) food processing factories (eg from a dairy factory) or other secondary industry. This means a wide variety of quality issues and quantities of water are catered for in the guidelines.

2.2 Content of the Guidelines

The guidelines have sections that outline:

- the **statutory framework** for irrigating with wastewater
- **principles** of wastewater irrigation
- **components** of wastewater irrigation schemes
- the **elements** contributing to sustainable wastewater irrigation that include:
- the **performance outcomes** for each element
    - **issues** relating to that element
    - the situation leading to different **risk levels**
    - **practices** to use (dependant on risk level) and
    - a **monitoring** and **review** process
- **environmental improvement framework**
- **a checklist**
- **roles and responsibilities**

3.0 PRINCIPLES OF IRRIGATING WITH WASTEWATER

Wastewater irrigation follows the same principles as other commercial irrigation. There are some extra positives and negatives from using wastewater for irrigation than usual irrigation sources, because of what the wastewater contains (eg nutrients, salts, and other toxicants).

The common mistake when irrigating with wastewater is to try and treat it differently to other irrigation systems.

Some examples of the key principles are listed below:

- using wastewater as a resource will generally result in lower costs to the community, than the alternative environmental costs of disposal to surface water systems
- plants perform best when supplied with adequate nutrients, aerated soil and water that can be taken up with relative ease
- plant evapotranspiration demand for water should drive supply of wastewater (amount & timing)
- applications of wastewater must not exceed the soil's capacity to provide suitable growing conditions for the plants

- commercial business viability of the irrigation system should underlie the planning
- agreement must be reached between the wastewater supplier and the user of the water for irrigation on the amount, seasonal supply and rate of water to be used
- operators require skills in the management of wastewater irrigation

The most common cause of failure occurs primarily when the principles of meeting plant evapotranspiration demand, business viability and operators skills are not applied.

4.0 COMPONENTS OF WASTEWATER IRRIGATION SCHEMES

There are five main components of an irrigation scheme. The five components are:

- treated water (water quality)
- site
- plant type
- irrigation type
- management

Each of these components is described, including some examples of the suitability of different situations to use wastewater for irrigation and some of the issues involved in assessing the situation.

An outline of options is given for each component, where these options are best suited, where they are not suited and what the boundaries are.

5.0 ELEMENTS CONTRIBUTING TO SUSTAINABLE WASTEWATER IRRIGATION

5.1 The Twelve Elements

Twelve elements will be described in the guidelines and they all need to be considered when developing appropriate management practices for irrigating with wastewater.

These elements are listed below in two groups. The first five relate to using wastewater (operator focussed) and the next seven are about protecting the beneficial use.

Using Wastewater	Protection of Beneficial Use
wastewater volume	soil
nutrients	surface water
salt and sodicity	groundwater
viability	human and stock health
other toxicants	public amenity
	native vegetation
	cultural heritage

Each element has its own set of performance outcomes that are needed to achieve the overall objective for wastewater irrigation.

To use the guidelines, the following steps are advised:

- check each element
- recognise the desired outcome
- determine the risk level associated with the element
- select an appropriate action (or practice) to achieve the outcome, given the existing risk level.

Each element can be worked through in turn, but the requirement to meet all outcomes means there is interaction between the elements. Therefore an iterative approach is needed to develop the final set of practices for the irrigation and land use system.

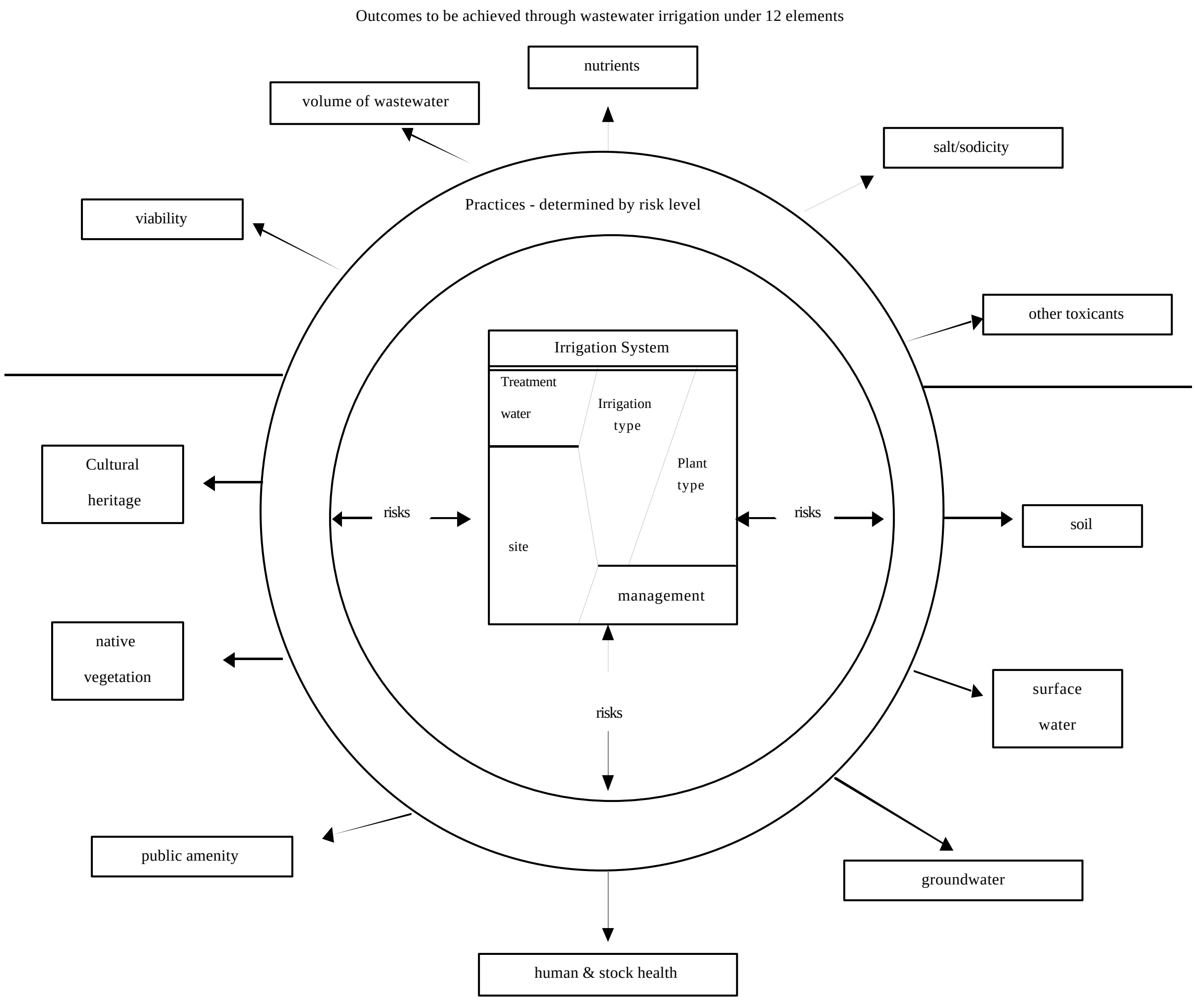
Each element has a brief description of the performance outcome, the issues associated with the element, the risks and indicative risk level, the practices (described for low and high risk situations), the review process and some further information sources.

How the components of the irrigation system come together and relate to the performance outcomes that must be achieved when irrigating with wastewater, is shown in Figure 1.

The situation that exists for each component of the irrigation system determines the risk level for irrigating with wastewater. These risk levels (high or low) lead to the selection of the most appropriate practice that will achieve the relevant performance outcome.

This process is repeated for each of the twelve elements that contribute to sustainable wastewater irrigation. As practices impact on several elements, practices that are selected to meet a performance outcome for a given risk level for one element will impact on the capacity to achieve the performance outcome in another element.

Figure 1: ***Irrigation System Practices, Risks and Performance Outcomes***



5.2 An Example of an Element - Nutrients

Nutrients are used here as an example of how the guidelines will be presented. Only parts of each section are included by way of illustration and as this is still in draft form, should not be relied upon as EPA's guidelines.

Performance Outcome

The objective with nutrients present in wastewater is to have them utilised in plant growth and removed safely from the site in plant (or animal) product. The resultant outcomes are:

- the applied (wastewater or additional fertiliser application) nutrients are utilised for plant growth or remain in the soil for future uptake by plants
- the applied nutrients do not build up in the soil to a level where they cause an adverse impact on beneficial use on site, or off-site, (via surface runoff or leaching into groundwater)

Issues

Nutrients are required for plant growth. To avoid depletion of the soil nutrients, they must be added (through wastewater or fertiliser) and stored in the soil for later uptake by plants.

Removing plant or animal products from the site takes nutrients out of the wastewater irrigation system. Some products remove more nutrients than others eg more phosphorus is removed in hay than in meat (an appendix will give examples of plant and animal products and the likely removal of nitrogen and phosphorus).

A number of other issues are also discussed

Risks

Of the range of nutrients required for plant growth, phosphorus (P) and nitrogen (N) are the most likely to have potential adverse impacts on the environment. Therefore the guidelines concentrate on these two nutrients.

The level of risk associated with achieving the stated performance outcomes varies in different situations. These risks are listed as being 'low risk' or 'high risk' and examples are shown in Table 1 below

Table 1: Some *Examples of Indicative Risk Levels - Nutrients*

Low Risk	High Risk
low levels of phosphorus in the wastewater (< 5 mg/l)	high concentration of phosphorus in the wastewater (> 10 mg/l)
low annual irrigation application rates (< 3 ML/ha/annum)	high annual irrigation application rates (> 6 ML/ha/annum)
sprinklers/drip centre pivot & linear move irrigation	flood irrigation without a functioning runoff re-use system
plant material regularly harvested and removed (eg hay, trees as the crop) ie high nutrient uptake with little nutrient cycling	adding additional fertiliser nutrient cycling on site ie nutrients return to soil rather than removed in product
poor quality groundwater (eg high N, P or salt) with very few beneficial uses - unsuitable for drinking or agricultural use	good quality groundwater (eg low salt, N and P levels) with many beneficial uses - potable water

Practices

Practices should be tailored to the level of risk for each given situation. In the guidelines the practices are listed under "low-risk" and "high-risk" categories, but only high-risk examples are given here. Where relevant, the practices are grouped under the sub-categories of investigation, operation & management, land system & irrigation type and monitoring.

High risk (exceeding nutrient balance)

Investigation

More detailed investigation, closer attention to management detail and more intensive monitoring must be carried out in a high-risk situation.

For example, it is important to accurately determine the soil nutrient loading capacity. This can be done by a number of practices, some of which are listed below:

- nutrient loadings (hydraulic loading times flow weighted concentration of nutrients)
- selection of appropriate crop (typical uptake rates of N are around 200 kg/ha/year and of P are 20 kg/ha/year - an appendix will show examples of crop nutrient uptake rates)
- investigate soil phosphorus retention capacity (dependent on soil texture, clay type and concentration of P) and therefore the P retention time.

For example, if the calculated P retention time to reach the soil capacity is less than 20 years the project needs to:

- find more area to irrigate, or
- reduce the concentration of nutrients (P in particular) in the wastewater, or
- reduce the amount of water applied to the site (may need a change of crop type).

Land System

Use crops that extract high levels of nutrients and avoid low use crops (eg woodlots).

Consider installing wetlands for stripping nutrients from rainfall runoff.

Operation and Management

Pay attention to detail on scheduling irrigation (both application rates and frequency) and make sure the site is not over irrigated.

Ensure surface runoff reuse systems catch all irrigation and any rainfall runoff that contains nutrients from wastewater.

Different elements have different details provided in each of these sections.

Monitoring

Examples given here relate to soil testing and nutrient balance.

Regular soil testing (topsoil N + P at least every 2 years) is needed to check that nutrients are not accumulating to critical levels.

A rolling three-year average nutrient balance should be calculated to see if there are changes to what was planned. This requires records of the following things to be kept for each independently managed area:

- water used
- applied water quality
- plant/animal product produced
- amount and type of fertiliser applied.

Review

A separate section on how to assess the data/information gathered from the monitoring is provided for each element.

Discussion in the guidelines takes the operators to options, depending on what the outcome is. For example, if the rolling average nutrient balance shows an increasing trend, or the soil tests show that critical levels have been reached, there must be:

- reduction of nutrients in the wastewater by changing the treatment process or providing additional on-farm N and P reduction prior to irrigation
- reduction in the annual applied water per hectare (by reducing the volume or increasing the area of irrigation)

6.0 ENVIRONMENTAL IMPROVEMENT PLAN FRAMEWORK

EPA will require an EIP to be developed for each site. The guidelines provide a suggested framework for authorities and users of the wastewater, to develop their own EIPs.

7.0 CONCLUSION

The BPEMG for Wastewater Irrigation has been written with a focus on clearly understanding the outcomes to be achieved for sustainable irrigation with wastewater. This is supported with explanations of risks and what constitutes high and low risk levels that lead the operators and managers to the most appropriate practices.

Previously wastewater practice guidelines have had less focus on risk management. These guidelines address that deficiency.

The guidelines will be robust, but can be flexible in determining how each of the required outcomes is achieved.

All producers and users of wastewater for irrigation should get a copy of the new BPEMG for Wastewater Irrigation when they are completed.