Evaluating Ecological Impacts to Wetlands Receiving Water from Engineering Interventions.

1. Introduction

1.1 Rationale

This document is proposed to advance the current system of assessment of Notices Of Intent to drain by developing methodologies that quantify and evaluate downstream biological impacts on wetlands from drainage proposals. The project further aims to evaluate the proposed methodologies by trialling them at various sites across the south-west agricultural region.

Previous efforts to develop evaluation criteria for drainage proposals have largely used hydrological and chemical parameters as surrogates for conservation condition of a wetland. Changes in these parameters have been seen as central to predicting impacts of drainage on receiving wetlands [see Coleman and Meney's (2003) *Review of safe disposal in salinity management for engineering options* and their earlier reports for CALM].

The Drainage Impacts Working Group recognize that considerable resources are often required to quantify the sensitivity of receiving wetlands to changes in hydrological and chemical parameters as a result of drainage disposal. A useful way forward is to adopt a streamed approach to the assessment of drainage proposals, similar to part of the process outlined by Coleman and Meney (2000). Different levels of assessment will be assigned to proposals for drainage disposal according to broad levels of conservation value of the receiving wetland (see Table 1).

The main outcome of the document is to identify three categories of wetlands in relation to proposals to drain into them. Category 1 wetlands need to be referred to the Environmental Protection Authority. Category 2 and Category 3 wetlands will be assessed within agencies, although Category 2 wetlands may be referred to the EPA. For Category 2 wetlands, impact on conservation values of the wetland will be a major component of the drainage assessment, which will utilise "expert" input and follow a similar approach to that outlined by Coleman and Meney (2000, 2003). It will usually be possible to drain into Category 3 wetlands, subject to evaluation revealing no adverse downstream effects.

The outcomes of this framework will be evaluated after twelve months to determine it's effectiveness in light of the multiple uses of water resources that include improving land use options and productivity, ecosystem services (including healthy functioning wetland systems), protection of infrastructure, water harvesting, wildlife corridor and ecological functions, water removal, and improvement in water quality.

1.2 Impacts of Drainage

The kinds of adverse impacts of drainage in receiving wetlands vary according to situation. If the endpoint of drainage is a closed wetland where overflow only occurs during flood events, the principal factors likely to cause adverse impact are increased

salinity (both concentration and salt load), increased flooding (or hydroperiod) of the wetland and increased area of adjacent wetted soil surface, elevated nutrient and heavy metal concentrations (or loads), and decreased pH if drainage waters are acidic. Impacts can also be caused by direct physical impacts of construction. High salinities change the species composition of aquatic plants (none grow at salinities over 60 g/L) and reduce the number of species of invertebrates and waterbirds using a wetland. Higher flood levels and prolonged inundation kill riparian vegetation and emergent species in a wetland (e.g. trees and sedges) as well as reducing the variety of invertebrates if the wetland is saline. Low pH has adverse affects on most plants and invertebrates, especially if the pH is very low and the wetland is saline. The few species adapted to low-pH salt lakes usually occur in seasonal (rather than permanently flooded) wetlands.

Few wetlands in the south-west are permanently closed and in wet years most overflow into one of the major drainage systems. Downstream impacts will occur, when a wetland overflows, if the accumulated salt load from drainage raises streamflow salinity significantly. Usually other downstream inflows from tributaries dilute the overflow salt load and after a variable distance downstream the impact of overflow becomes negligible. Nutrients in overflow water have downstream impacts as flow recedes and pools form. They may also affect estuaries if overflow water travels to the coast.

Sometimes drains may be directed into creeklines. In these cases, increased sediment loads and nutrients are probably of as much concern as salinity, hydroperiod and acidity. It is likely the nature of the stream will be completely changed if it is receiving continual low volumes of highly saline, perhaps nutrient-rich or acidic water. Satellite images have documented that flood events cause scouring of drains and transfer sediment into small creeks, where it will settle out in the first pool. Damage will not be restricted to the creek channel; in many cases riparian vegetation is likely to be killed by drainage water (or by higher salinities under the streambed).

1.3 Project Background

In 1996 the WA Government produced a Salinity Action Plan that recognized that while drainage is a useful tool for salinity management, drainage disposal is a potential threat to the environmental values of downstream wetlands. The Salinity Action Plan recommended that bodies authorized with evaluation of drainage schemes should assess proposals including the use of environmental criteria.

It has remained difficult to define an evaluation process to assess potential threats that both satisfies basic benchmarks of scientific rigor and remains cost effective and useable by land managers for rapid appraisal of downstream impacts. Previously proposed evaluation methods include Coleman and Meney (1998) and Coleman and Meney (2000). These methods regarded current biological inventory and knowledge ecosystem processes as too sparse to use as a basis for evaluating potential impacts on receiving wetland systems. As a result, they used hydrological and chemical measurements as surrogates for biological values and the criteria for assessment were based on estimates of the extent to which hydrology and chemistry could change without biological impacts. Coleman and Meney (2000) proposed some biological assessment in more complex evaluations.

More recently, Coleman and Meney (2003) reviewed safe drainage disposal practices. They reported that the Salinity Engineering Workshop had recommended (1) work to identify the key changes in hydroperiod and water quality that affected biodiversity, (2) dissemination of information about criteria for determining suitability of wetlands as drainage disposal sites and (3) that tools be provided to assist landholders and others make decisions about disposal options for drainage. Coleman and Meney (2003) themselves recommended that wetlands should be classified into categories reflecting 'sensitivity to hydrological change'.

1.4 Monitoring and Evaluation

Monitoring and evaluation is an essential part of adaptive management and provides a feedback loop enabling outcomes of earlier management regimes to lead to improved management methods. Currently, the resources that would be required to monitor all drainage proposals adequately for downstream impacts acts is a deterrent to monitoring being adopted. However, unless drainage schemes are monitored, the opportunity to assess biological impacts at receiving wetlands, and to improve drainage design subsequently, will be lost.

Proponents of drainage schemes that discharge into Category 1 or 2 wetlands may be required to monitor as a condition of approval to discharge. It is also important that biological impacts of drainage into Category 3 wetlands are better documented. In order to achieve this, a small number of Category 3 wetlands receiving drainage should be monitored by agency personnel. Drainage stakeholders are also encouraged to include collect information that will allow assessment of the effectiveness of their drains in terms of farm productivity and impacts on downstream wetlands. Parameters that should be monitored in order to assess impacts of drainage include:

1. Volume of flow leaving by the drainage system.
2. Number of months that the drain flows.
3. Average pH and salinity of drainage water.
4. Depth and number of months the receiving body contains water.
5. Average pH and salinity of the receiving body.
6. Condition of wetland-associated vegetation around the receiving body.

Consideration should also be given to monitoring the waterbird and aquatic invertebrate communities and the percentage cover of submerged macrophytes and/or benthic mats in the receiving body. Where nutrient enrichment is expected to occur the nutrient status of the receiving waters should also be monitored.

Government agencies will provide advice on the best methods of monitoring drainage systems. Useful resources include the Water and Rivers Commission *Manual on River Restoration* (2000) and Bushcare's *Monitoring and Evaluating Biodiversity Conservation Projects* (2003).

2. **Guidelines for assessing the impact of deep drainage on downstream aquatic ecosystems in the Wheatbelt region of Western Australia**

Steps for determining whether waterbodies can receive deep drainage

Step 1. Determine the conservation status of the primary receiving waterbody by classifying it as Category 1, 2 or 3 using Table 1 and Table 2:

Outcome of Step 1.

Applications to drain into Category 1 wetlands must be referred to the EPA.
Category 2 wetlands (go to Step 2).
Category 3 wetlands (go to Step 3)

Step 2. Applications to drain into Category 2 wetlands will be evaluated by agencies using the Coleman and Meney (2003) approach, and the criteria given here. These evaluation criteria include impacts to the wetland character descriptors used in Table 1 and the processes described in Section 1.2 of this document.

Outcome of Step 2.

If there is moderate to high probability that drainage will cause significant damage to receiving wetland, the application will be referred to the EPA
If the waterbody is deemed suitable for drainage, go to Step 3

Step 3. Drainage into Category 2 or 3 wetlands can only occur if it can be demonstrated that there is low probability that Category 1 or 2 wetlands farther downstream (final receiving bodies) will be affected. This will be done using the Coleman and Meney (2003) approach and expert knowledge according to the threat framework described in Step 2. The impact on estuarine and near shore marine regions that may receive elevated loads of salt, sediment, nutrients or heavy metals must also be considered if the drainage scheme is large or located near the coast.

Outcome of Step 3,

If downstream waterbodies will suffer significant damage, the application will be referred to the EPA where these waterbodies include category 2 or 3 wetlands.
If damage is minimal, proceed with drainage scheme

Table 1 Classification of wetlands according to their suitability for receiving drainage.

Category	Condition	Vegetation	Salinity	Lakebed	Comments
1	near natural	mostly intact	fresh or naturally saline	evidence of aquatic plants present in last wet phase and/or naturally occurring benthic mats	high conservation value, ecologically healthy, may contain species or processes lost elsewhere
2	significant anthropogenic disturbance (1° or 2° saline)	significant death, particularly close to water	brackish or saline (if originally fresh, can still be fresh or brackish after large inflow)	evidence of aquatic plants present in last wet phase and/or naturally occurring	productive, moderately species rich 2° wetlands often supporting large numbers of waterbirds, or 1° wetlands with increased hydroperiod and flooding. Have conservation value.

				benthic mats	
3	considerable anthropogenic disturbance (1° or 2° saline)	extensive death, often extending well up wetland bank to maximum flood level or beyond	saline (even after large inflow originally fresh systems remain saline)	lakebed with very thick, hard crust of salt crystals when dry means lake is in this category	conservation value reduced, salinities often very high, may have groundwater seeps in summer associated with thick salt crust and no evidence of benthic mats

Category 1
Wetlands (including stream sections) that largely fulfill the definition of a 'healthy' wetland. These are of the highest conservation value as they contain species and processes that may have been lost elsewhere and the impact of drainage will usually be negative.

Category 2
Wetlands (including stream sections) that substantially fulfil the definition of a 'healthy' wetland. The extent to which the water regime, biotic features and ecological processes have been altered determines whether conservation value is high or low and whether there are opportunities to dispose of drainage. The impact of drainage into these wetlands will often be negative.

Category 3
Wetlands (including stream sections) that have been significantly altered by anthropogenic influences and have little probability of returning to a 'healthy' condition even with active restoration and management. In most situations, these waterbodies will be able to receive drainage waters, subject to any additional downstream effects being evaluated.

Healthy wetlands
An ***ecologically healthy*** wetland is defined as a wetland that possesses most of the plant, fungal, bacterial and animal communities, and nearly all of the ecological processes, which would be expected in response to its location and landscape setting (geology, bathymetry, water balance, landscape linkages) when unaffected by major human influences.

Characteristics of an ecologically healthy wetland include:

- a water regime and ecological communities and processes that have been little altered by anthropogenic disturbances;
- the water column, littoral region and adjoining wetland-influenced vegetation comprise indigenous plant and animal species with few or no exotic or invasive species;
- the presence of natural habitats and geomorphological features ;
- sufficient landscape linkages between wetlands to support biological features and maintain ecological processes (e.g. recolonisation)

This definition incorporates similar elements to those in the definition of an *ecologically healthy* river developed by the Victorian River Health Strategy. The definition recognises that many Australian wetlands are extremely dynamic, with plant and animal communities, and ecological processes, responding primarily to a highly variable (seasonal, intermittent or episodic) water regime. As a consequence,

this definition does not necessarily invoke a condition similar to that of pre-European settlement, although it is likely that many healthy wetlands do reflect a condition similar to those times.

Assessment

Wetlands that have been assessed as Category 1, 2 or 3 are listed in Table 2 (*at present this list is indicative*). For other wetlands, biological surveys and description of the water regime, major ecological processes and landscape linkages are the most effective way of determining their conservation status. However, it is recognised that a small number of indicators can be used effectively by "expert panels" to classify wetlands where resources are not available for more detailed surveys.

Equity of drainage opportunity

Coleman and Meney (2000) proposed that in most cases changes to physico-chemical parameters in a wetland should not exceed 10 % after the impacts of all potential drainage proposals were considered. They suggested that the amount of impact from a single proposal should be calculated according to the proportion of the catchment being drained. The Drainage Working Group believes this approach does not always align well with the way drainage proposals may develop and the catchment sheds water. Accordingly, calculations of the likely impacts of all potential drainage should be based on the amount of water likely to be shed from each catchment, rather than its area, and should also be adjusted to account for the likelihood of each catchment being drained.

Table 2. List of wetlands by category (*as determined on May 1, 2004 – current list is indicative only and wetlands have not been put through assessment process*)

Category	Wetland
Category 1	Toolibin, Yaalup, Noobijup, wetland in Paperbark NR, Wheatfield, Kulicup, Altham, Weelhamby etc
Category 2	Coyrecup, Walymouring, Coomelberrup, Moora Lakes (many of the named lakes in the wheatbelt) etc
Category 3	Gundaring, Gounter, Brown (near Yealering), many of the un-named lakes on farmland etc

Bibliography

Coleman and Meney (1998) *Evaluation Criteria for Assessment of Wetlands Receiving (Saline) Drainage.* DEP, Perth, WA.

Coleman and Meney (2000) *Impacts of Rural Drainage on Nature Conservation Values-Proposed Evaluation Guidelines.* Actis Environmental Services and Regeneration Technology Pty Ltd. Perth, WA.

Coleman and Meney (2003) Technical Report *Review Of Safe Disposal In Salinity Management For Engineering Options.* Syrinx Environmental PL/actis Environmental Services. Perth, WA