# Irrigation Drainage Memorandum of Understanding Decision Support System

# Assumptions for Management Actions

## North Central Catchment

**Final Document — 22 January 2007**

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**(with support from Hydro Environmental)**

# INDEX

# LIST OF APPENDIX



# LIST OF TABLES

# 1. Purpose

This document has been produced for the Irrigation Drainage Memorandum of Understanding (IDMOU)[1] steering committee. The purpose of the document is to identify the assumed relationships between Management Actions (MA) and Resource Condition (RC) outcomes in the North Central Catchment. This information is used in the rapid Decision Support System (DSS)[2] to assist in the setting of water quality and management action targets.

# 2. Background

## 2.1 IDMOU

The IDMOU[3], signed on the 22 June 2004, sets out the key responsibilities of the agencies involved in the management of irrigation drainage systems in northern Victoria. The signatories to the memorandum are:

- Department of Sustainability and Environment (DSE)
- Environment Protection Authority (EPA)
- Goulburn Broken Catchment Management Authority (GBCMA)
- North Central Catchment Management Authority (NCCMA)
- Goulburn-Murray Water (G-MW).

## 2.2 North Central Catchment

The North Central Catchment covers an area of almost 3,000,000 ha in northern Victoria incorporating both dryland and irrigated agriculture. In a typical year the irrigated area located within the catchment is between 300,000 and 350,000 ha, the irrigation season generally occurs between 15 August and 15 May each year. In addition 150,000 to 300,000 ha of dryland is managed by irrigation farmers, this represents a total "irrigation area" of approximate 700,000 ha.[4]

The three main agricultural systems practiced within the region are dairying, mixed farming and horticulture.

## 2.3 North Central Catchment Water Quality Issues

Salinity and elevated nutrient levels (particularly phosphorus) are the main water quality issues within the region[5]. Nutrients are essential for the functioning of healthy ecosystems, however elevated levels have the potential to stimulate the excessive production of algal growth.

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[1] Department of Sustainability & Environment (June 2004), *Memorandum of Understanding for Irrigation Drainage Management & Water Quality,* Hydro Environmental

[2] Department of Sustainability & Environment (December 2005), *IDMOU Rapid Management Action Decision Support System, First Draft*, Hydro Environmental

[3] Department of Sustainability & Environment (June 2004), *Memorandum of Understanding for Irrigation Drainage Management & Water Quality,* Hydro Environmental

[4] North Central Catchment Management Authority (March 2003), *North Central Regional Catchment Strategy,* North Central Catchment Management Authority, Huntly

[5] North Central Catchment Management Authority (March 2003), *Loddon Nutrient Management Strategy,* North Central Catchment Management Authority, Huntly

# 3. Resource Conditions

## 3.1 General

Many of the assumptions detailed in this document have been sourced from the Loddon Murray Irrigation Region Surface Water Management Implementation Plan (LMIRSWMIP)[6] the Estimates of Flow and Salt Load Drainage Yield Rates report[7] and the LMIRSWMIP Downstream Water Quality and Quantity Impacts Technical Background Paper No. V3.1.5 both produced by SKM[8].

Changes to flow, salt and nutrient loads resulting from additional drainage proposed in the LMIRSWMIP were produced for each catchment based on the work carried out by Camp, Scott and Furphy (CMPS&F) in the Koondrook-Murrabit area (CMPS&F, 1995)[9]. CMPS&F produced a Community Surface Drainage Feasibility Study that examined a range of impacts from two proposed drainage areas in the Koondrook-Murrabit area. These two catchments were referred to as the Murrabit Drain 1 catchment and the Koondrook Drain 1 catchment. In the CMPS&F study, flows from the two catchments were estimated using the HYDROLOG rainfall-runoff model (the Monash model).[10]

## 3.2 Modelled Flow

The increase in flow per unit area drained for the two CMPS&F study catchments were 0.382ML/ha/yr for Koondrook Drain 1 and 0.357ML/ha/yr for Murrabit Drain 1[11], this is summarised in Table 1.

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[6] North Central Catchment Management Authority (January 2004), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Volume 1(Draft),* North Central Catchment Management Authority, Huntly.

[7] Neal, B.(October 2005), *Estimates of Flow and Salt Load Drainage Yield Rates,* Sinclair Knight Merz

[8] North Central Catchment Management Authority (September 2003), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Downstream Water Quality and Quality Impacts Technical Background Paper No. V3.1.5,* North Central Catchment Management Authority, Huntly

[9] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

[10] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

[11] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

**Table 1 - Summary Of Flow Related Information**[12]

| Parameter | Source | Comments |
|---|---|---|
| **Flow** | | |
| 0.382ML/ha/yr | Draft LMIRSWMIP – Downstream Water Quality and Quality Impacts Technical Background Paper No. V3.1.5 | • From CMPS&F study 1995<br>• HYDROLOG rainfall-runoff model (the Monash model)<br>• Included effects of re-use systems proposed at the time<br>• Koondrook Drain 1 |
| 0.357ML/ha/yr | Draft LMIRSWMIP – Downstream Water Quality and Quality Impacts Technical Background Paper No. V3.1.5 | • From CMPS&F study 1995<br>• HYDROLOG rainfall-runoff model (the Monash model)<br>• Included effects of re-use systems proposed at the time<br>• Murrabit Drain 1 |
| 5.6ML/drain km/yr | Draft LMIRSWMIP – Downstream Water Quality and Quality Impacts Technical Background Paper No. V3.1.5 | • MIDASS drain modelling<br>• For every km of drain<br>• Tragowel Plains, 1994 |
| -25ML | NRRS[(i)] assumed | • Each NRRS is assumed 25ML hence 25ML/yr reduction is assumed. Each NRRS serves 100ha |

(i) NRRS — Nutrient Reduction Re-use Systems

### 3.3 ***Modelled Salinity***

The salt load increases per unit drained area for the two CMPS&F study catchments were 0.16 t/ha/yr for Koondrook Drain 1 and 0.15 t/ha/yr for Murrabit Drain 1[13]. The soil type of the two catchments varied hence two values were calculated (Koondrook Drain 1 clay loam soils, Murrabit Drain 1 clay soils). Table 2 summarises the findings.

**Table 2 - Summary Of Salinity Related Information**

| Parameter | Source | Comments |
|---|---|---|
| **Salt** | | |
| 0.16 t/ha/yr | Draft LMIRSWMIP – Downstream Water Quality and Quality Impacts Technical Background Paper No. V3.1.5 | • From CMPS&F study 1995<br>• From Koondrook Drain 1 |
| 0.15 t/ha/yr | Draft LMIRSWMIP – Downstream Water Quality and Quality Impacts Technical Background Paper No. V3.1.5 | • From CMPS&F study 1995<br>• From Murrabit Drain 1 |
| 114 t/drain km/yr | Basin Salinity Management Strategy Annual reports | • From Tragowel Plains |

### 3.4 ***Catchment Specific Flow and Salinity Data***

Where other sources of information exist (e.g. gauged data, pumping times) it has been used (see table 3 for specific catchment details and assumptions).

[12] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

[13] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

**Table 3 - Summary Of Flow And Salinity Related Information[14]**

| | |
|---|---|
| **Swan Hill** | |
| Flow (ML/yr) | 194,600 (based on a total area of 43,250 ha) |
| Salt load (t/yr) | 7,500 |
| Method of calculation and additional data | ▪ Average annual drainage in Tyntynder Drains 3 and 4 is 6,205ML, averaged over 1994 and 1995 (SKM, 2000). The combined catchment area of these drains is assumed to be 13.9 $km^2$. This equates to a drainage rate 4.5ML/ha/yr.<br>▪ Salt load estimate from SKM (2000) for Tyntynder Flats drains. |
| The values detailed above for the Swan Hill catchment are considered to be significantly inaccurate as they are based on pump electricity readings rather than flow readings. Therefore a concentration of 300 mg/l has been used as a best fit estimate of the actual concentration for this catchment based on anecdotal evidence. | |
| | |
| **Fish Point** | |
| Method of calculation and additional data | ▪ No data exists for the entire catchment so CMPS&F (1995) findings were used (i.e. 0.16 t/ha/yr and 0.382 ML/ha/yr). |
| | |
| **Koondrook-Benjeroop** | |
| Flow (ML/yr) | 2,530 (based on a total area of 12,640 ha) |
| Salt load (t/yr) | 760 (based on a total area of 12,640 ha) |
| Method of calculation and additional data | ▪ In 1995 it was found that nearly 70% of landholders dispose of drainage water by pumping to irrigation channels. Other destinations were road reserves, creeks, rivers or forest. The average drainage pumping rate was estimated to be 0.2ML/ha/yr.<br>▪ The assumed salt yield rate was between 0.05 and 0.07 t/ha/yr. |
| | |
| **Kerang Lakes** | |
| Method of calculation and additional data | ▪ No data exists for the entire catchment so CMPS&F (1995)[15] findings were used (i.e. 0.16 t/ha/yr and 0.382 ML/ha/yr). |

**Cont.**

[14] Sinclair Knight Merz (October 2005), *Estimates of Flow Salt Load Drainage Yield Rates,* Sinclair Knight Merz

[15] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

| **Barr Creek** | |
|---|---|
| Flow (ML/yr) | 48,200 |
| Salt load (t/yr) | 166,900 |
| Method of calculation and additional data | ▪ The above drainage rates are historic flow and salt load, measured in Barr Creek at Capels crossing (407252), from Jan-1975 to Jul-2005.<br>▪ Since the inception of the Barr Creek Catchment Strategy in 1987, both flows and salt loads in Barr Creek have diminished. In 2003, a statistical tool known as the Generalised Additive Model (GAM) was used to demonstrate that there was an unexplained downward trend in flow and salt load, even after accounting for the generally lower rainfall from 1987/88 onwards.<br>▪ Recent statistical modelling has indicated that the modelled historic in-season (Aug-May) flow in Barr Creek is 40,500ML, and the modelled historic in-season salt load is 135,100 tonnes, exclusive of flows derived from Calivil and Nine Mile Creeks. However, after having accounted for the effects of the Barr Creek Catchment Strategy, modelled in-season flows and salt loads were found to be 30,000ML and 110,300 tonnes respectively. |

| **Gunbower Island** | |
|---|---|
| Flow (ML/yr) | 6,910 |
| Salt load (t/yr) | 2,070 |
| Method of calculation and additional data | ▪ Drainage rates as per Koondrook-Benjeroop and based on a total area of 34,550 ha (i.e. 0.06 t/ha/yr and 0.2 ML/ha/yr). |

| **Boort West** | |
|---|---|
| Flow (ML/yr) | 2,880 |
| Salt load (t/yr) | 5,760 |
| Method of calculation and additional data | ▪ Drainage rates as per Calivil Creek and based on a total area of 28,820 (i.e. 0.02 t/ha/yr and 0.1 ML/ha/yr). |

| **Wandella Creek** | |
|---|---|
| Flow (ML/yr) | 6,500 |
| Salt load (t/yr) | 13,000 |
| Method of calculation and additional data | ▪ Drainage rates as per Calivil Creek and based on a total area of 65,000 ha (i.e. 0.02 t/ha/yr and 0.1 ML/ha/yr). |

| **Loddon** | |
|---|---|
| Flow (ML/yr) | 5,390 |
| Salt load (t/yr) | 10,780 |
| Method of calculation and additional data | ▪ Drainage rates as per Calivil Creek and based on a total area of 53,910 ha (i.e. 0.02 t/ha/yr and 0.1 ML/ha/yr). |

**Cont.**

| **Calivil Creek** | |
|---|---|
| Flow (ML/yr) | 6,210 |
| Salt load (t/yr) | 11,560 |
| Method of calculation and additional data | ▪ The above drainage rates are historic flow and salt load, measured in Nine Mile Creek at Coads Road (407284) and Calivil Creek at Wisharts Road (407285), from Jul-1979 to Oct-2003, excluding Loddon River over-bank flood flows, which can enter Nine Mile Creek via Serpentine Creek.<br>▪ The Nine Mile and Calivil Catchments drain an area of 57,800 ha. The flow and salt loads correspond to yield rates of 0.1ML/ha/yr and 0.2 tonnes/ha/yr.<br>▪ Recent statistical modelling has indicated that the flow and salt load in these streams at 1988 levels of development is likely to be in the order of 9,520ML/year and 12,180 tonne/year respectively, when Loddon River flood flows are included. Post-1988 drainage works within the Tragowel Plains has increased the rate of drainage, but this increase has been partially countered by the net loss of permanently transferred water entitlements (PTWE) from the region. The flow and salt export rate, with drainage and PTWE at 2002 levels of development, is in the order of 9,830ML/year and 12,320 tonnes/yr, respectively. As these rates include Loddon River flood flows, they cannot be directly compared to the rates presented above. |
| | |
| **Pyramid Creek** | |
| Flow (ML/yr) | 8,850 |
| Salt load (t/yr) | 17,690 |
| Method of calculation and additional data | ▪ Drainage rates as per Calivil Creek and based on a total area of 88,460 ha (i.e. 0.02 t/ha/yr and 0.1 ML/ha/yr). |

### *3.5 Salinity*

Salinity levels for each catchment were calculated using the data captured in Table 3. Salt load was divided by the flow to arrive at kg/ML. This was multiplied by 1,000 to get mg/L as depicted in table 9.

**Table 4 - Calculated Salinity Levels For Each Catchment**

| Plan Catchment | Salt Concentration (mg/L) | Salt Concentration (µs/cm) |
|---|---|---|
| Swan Hill | 300 | 469 |
| Fish Point | 420 | 656 |
| Koondrook-Benjeroop | 300 | 469 |
| Kerang Lakes | 420 | 656 |
| Barr Creek | 3,463 | 5,410 |
| Gunbower Island | 300 | 468 |
| Boort West | 2,000 | 3,125 |
| Wandella Creek | 2,000 | 3,125 |
| Loddon | 2,000 | 3,125 |
| Calivil Creek | 1,862 | 2,909 |
| Pyramid Creek | 1,999 | 3,123 |
| Average | 1,369 | |

It should be noted that anecdotal evidence suggests that it would be unlikely that any catchments in the Loddon-Murray area would have regional drain salinity concentrations below 1,000 µs/cm.

It is also important to note that the salinity of farm run-off may be significantly different to the salinity of irrigation drainage, due to some irrigation drains intercepting groundwater.

### *3.6 Land use*

Land use splits for each of the 11 Loddon-Murray catchments in the LMIRSWMIP were estimated using irrigation farm survey data[16]. The percentage split was applied to the additional area to be drained to calculate the area of dairy and mixed farming enterprises, see Table 5 for details.

### *3.7 Phosphorus*

Nutrient concentrations associated with particular land uses were previously calculated in the Torrumbarry East of Loddon (TEOL) Land and Water Management Plan (L&WMP) and this was used by SKM in the LMIRSWMIP[17]. Typical runoff concentrations are 0.08 mg/L total phosphorus for areas of predominantly mixed farming, based on monitored values in Nine Mile Creek and Calivil Creek. Runoff concentrations for areas of predominantly dairy (irrigated perennial pasture) were assumed to be 0.85 mg/L total phosphorus, based on median recorded values in the Barr Creek catchment.[18]

The concentration values were then multiplied by the land use areas to get the typical runoff concentrations at the catchment scale. The results are shown in Table 5.

The average concentration of phosphorus was calculated to be 0.29 mg/L for the 11 sub-catchments. This has been used in table 1 for all management actions that are associated with water in a SWMS (e.g. drainage diversion, wetlands). For those management actions that influence water on-farm (e.g. re-uses systems) a phosphorus concentration of 0.85mg/L has been used.

For wetlands the assumed impact on the concentration of phosphorus has been calculated. The impact on concentration of phosphorus is highly dependent on the retention time and as such appendix 7 and 8 should be consulted.[19]

Please note that the concentration of phosphorus and suspended solids at the farm scale are likely to be higher than those at the regional scale. Processes occurring in farm surface water management systems and re-use systems, and in regional surface water management systems are not well understood and impact on the concentrations out-falling to natural waterways.

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[16] Goulburn-Murray Water (December 2003), *Irrigation Farm Survey 2001/02,* Goulburn-Murray Water, Tatura

[17] North Central Catchment Management Authority (September 2003), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Downstream Water Quality and Quantity Impacts Technical Background Paper No. V3.1.5,* North Central Catchment Management Authority, Huntly

[18] North Central Catchment Management Authority (September 2003), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Downstream Water Quality and Quantity Impacts Technical Background Paper No. V3.1.5,* North Central Catchment Management Authority, Huntly

[19] Department of Land & Water Conservation New South Wales (1998), *The Constructed Wetland Manual,* Volume 2, Department of Land & Water Conservation New South Wales

**Table 5 - Phosphorus Concentrations For Each Catchment**[20]

| Catchment | Land use (% of total land) | TP (mg/L) |
|---|---|---|
| Swan Hill | 20% dairy, 57% mixed farming | 0.10 |
| Fish Point | 3% dairy, 90% mixed farming | 0.06 |
| Koondrook-Benjeroop | 69% dairy, 30% mixed farming | 0.87 |
| Kerang Lakes | 0% dairy, 71% mixed farming | 0.06 |
| Barr Creek | 51% dairy, 42% mixed farming | 0.85 |
| Gunbower Island | 54% dairy, 41% mixed farming | 0.85 |
| Boort West | 0% dairy, 80% mixed farming | 0.06 |
| Wandella Creek | 7% dairy, 65% mixed farming | 0.06 |
| Loddon | 11% dairy, 65% mixed farming | 0.07 |
| Calivil Creek | 16% dairy, 70% mixed farming | 0.08 |
| Pyramid Creek | 21% dairy, 64% mixed farming | 0.10 |

### *3.8 Suspended Solids*
A number of drains and streams across the SIR are sampled fortnightly or monthly as part of the Victorian Water Quality Monitoring Network. The median concentration for suspended solids for the period 1999-2005 is approximately 50mg/L[21]. It has been assumed that this appropriately represents a realistic suspended solids concentration and therefore has been used for the purposes of this document.

### *3.9 Nitrogen*
Nitrogen has not been considered in this paper, phosphorus is considered the key driver due to its influence on ecosystems particularly algae growth.

## 4. Management Actions
The formulation of relationships between Management Actions and Resource Condition outcomes has been based on relevant:

- technical documentation
- existing water quality data
- anecdotal evidence from the Department of Primary Industries (DPI) and Goulburn-Murray Water (G-MW) representatives.

### *4.1 General*
To achieve reductions in phosphorus loads outfalling from irrigation drains the following aspects need to be achieved:

- irrigation farms should have an approved whole farm plan,
- irrigation farms should have functioning reuse systems,
- reuse systems should be used effectively by encouraging installation of electric power (to more easily manage automation of pumping),
- dairy effluent systems should be managed in accord with best management practice, including no farm directly discharging dairy effluent to drains,
- farmers should implement fertiliser BMPs.

[20] North Central Catchment Management Authority (September 2003), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Downstream Water Quality and Quantity Impacts Technical Background Paper No. V3.1.5,* North Central Catchment Management Authority, Huntly

[21] Smith, G. (2006) Goulburn-Murray Water, *Pers. Comms.*

The Management Actions investigated to determine their relationships with Resource Condition Outcomes were:

- Irrigation reuse systems,
- Nutrient Reduction Reuse Systems (including the benefits of irrigation tailwater reuse for the property which it serves),
- Drainage diversion (high flow and low flow),
- Wetlands (in-line, off-line and terminal),
- Surface Water Management Systems.

The analyses are presented in terms of cost per outcome (e.g. reduction in irrigation tailwater runoff) and cost per output (e.g. per volume of storage).

Tables 1 and 2 depict, in a general sense, the assumed impact of a range of management actions on water quality parameters and the likely costs of these actions. This information along with the information contained in section 7 is used in the IDMOU Rapid Management Action DSS[22]. The supporting text detailing how these assumptions were determined is presented throughout this document.

[22] Department of Sustainability & Environment (December 2005), *IDMOU Rapid Management Action Decision Support System, First Draft*, Hydro Environmental

## 5. Management Action Assumed Impacts

Outcome based measures are directly related to the effects of undertaking an action (e.g. the retention of irrigation tailwater is an outcome of constructing reuse storage capacity). Table 6 shows the water quality parameter load per outcome unit (i.e. per ML of water reused).

**Table 6 - Assumed Impact Of Management Actions On Water Quality — Outcome Based**

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salt | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of water reused equates to 1ML of irrigation tailwater not entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 1,369kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.04/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of water reused equates to a 1ML reduction in irrigation tailwater entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 1,369kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.06/t salt<br>$1.73/kg SS |
| Drainage Diversion (high flow) | Every 1ML of water diverted equates to a 1ML reduction in irrigation tailwater entering natural waterways | Every 1ML of water used equates to a decrease of 0.29kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 1,369kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | $55/ML<br>$190/kg P<br>$0.04/t salt<br>$1.10/kg SS |

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salt | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Drainage Diversion (low flow) | Every 1ML of water diverted equates to a 1ML reduction in irrigation tailwater entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.29kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 1,369kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | $27/ML<br>$94/kg P<br>$0.02/t salt<br>$0.55/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.023kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $3,495/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.145kg of P entering natural waterways (assumes 50% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $255/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | Every 1ML of water directed to a terminal wetland equates to a 1ML reduction in irrigation tailwater entering natural waterways | Every 1ML of water directed to a terminal wetland equates to a decrease of 0.29kg of P entering natural waterways | Every 1ML of water directed to a terminal wetland equates to a decrease of 1,369kg of salt entering natural waterways | Every 1ML of water directed to a terminal wetland equates to a decrease of 50kg of SS entering natural waterways | N/A |

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salt | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.29kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 1,369kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost (discount rate = 8 % for 30 year period).

(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based measures are directly related to the actions that are undertaken (e.g. the construction of 1ML re-use storage capacity is an output). Table 7 shows the water quality parameter load per output unit (i.e.ML of storage).

**Table 7 - Assumed Impact Of Management Actions On Water Quality — Output Based**

| Management action | Assumed volumetric achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salt | Assumed annual impact on suspended solids (SS) | Cost(i) to implement ($/ML of capacity) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 11,089kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 3,560kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water entitlement allocated to a drainage diversion system equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water allocated to a diversion entitlement equates to a decrease of 0.435kg of P entering the drainage system | Every 1ML water allocated to a diversion entitlement equates to a decrease of 2,053kg of salt entering natural waterways | Every 1ML of water allocated to a diversion entitlement equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.06kg of P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 274kg salt entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg SS entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost (discount rate = 8 % for 30 year period)

The outputs for drainage diversion (low flow) and all wetlands are identical to the outcomes, therefore no multiplication factor exists for these management actions, a ML of capacity equates to a ML re-used.

# 6. Irrigation Re-use Systems

## *6.1 Assumptions*

In order to determine the quantity of nutrients retained on-farm through the implementation of a reuse system, the following assumptions have been made:

- permanent pasture is irrigated 20 times per irrigation season,
- annual pasture is irrigated 4 times per irrigation season,
- permanent pasture water use is 10ML/ha/yr with an irrigation intensity of 50 mm (0.5ML/ha) per irrigation event,
- annual pasture water use is 4ML/ha/yr with an irrigation intensity of 150 mm (1.5ML/ha) for the initial irrigation event and 50mm (0.5ML/ha) for subsequent irrigations,
- on an annual pasture system, the runoff factor (7.5%) is only applied to 50mm (0.5ML/ha) of the initial irrigation, as the remainder is considered to not generate runoff because it is providing the initial wetting up of the soil,
- irrigation tailwater from irrigated pasture in the North Central Catchment has a phosphorus concentration of 0.85 mg/L.

Farm size and landuse (permanent/annual pasture and crop) will vary across the catchment resulting in varied runoff rates and therefore reuse capacities. However, it is assumed that the change in reuse system capacity will be proportionate and therefore catchment averages for reuse assumptions can be used. Table 8 shows the key assumptions used to determine the outcomes expected from re-use systems.

**Table 8 - Re-Use System Assumptions**

| Item | Unit | NC Farm | Permanent Pasture | Annual Pasture/Crops |
|---|---|---|---|---|
| Average Farm Size[23] | ha | 107 | | |
| Average Area of Pasture Type per Farm[24] | ha | | 25 | 82 |
| Irrigation Events per Year | No. | | 20 | 4 |
| Irrigation Intensity per Irrigation Event | mm/ha | | 50 | 50 |
| Irrigation Intensity per Irrigation Event | ML/ha | | 0.5 | 0.5 |
| Irrigation Intensity per Year | ML/ha | - | 10 | 2 |
| Proportion of Runoff per Irrigation Event | % | | 15% | 7.5% |
| Runoff per Irrigation Event | ML/ha | 0.113 | 0.075 | 0.038 |
| Runoff per Farm per Irrigation Event | ML | 4.95 | 1.875 | 3.075 |
| Average Reuse System Capacity per Farm[25] | ML | 4.9 | | |
| Reuse System Efficiency | % | 80% | | |
| Average Effective Reuse System Capacity per Farm (80% efficiency) | ML | 3.92 | | |

**Cont.**

[23] Goulburn-Murray Water (December 2006), *Irrigation Farm Survey 2004/05,* Goulburn-Murray Water, Tatura

[24] Goulburn-Murray Water (December 2006), *Irrigation Farm Survey 2004/05,* Goulburn-Murray Water, Tatura

[25] Emmett, S. (February 2006), Department of Primary Industries, *Pers. Comms.*

| Item | Unit | NC Farm | Permanent Pasture | Annual Pasture/Crops |
|---|---|---|---|---|
| Runoff Reuse per coincident Irrigation Event (80% reuse system efficiency) | ML/Yr | 3.96 | 1.50 | 2.46 |
| | | | | |
| Runoff per Farm per Year | ML/yr | 49.80 | 37.50 | 12.3 |
| Runoff Reused per Farm per Year (80% reuse system efficiency) | ML/Yr | 39.84 | 30.00 | 9.84 |
| Proportion of Runoff Reused per Farm per Year (80% reuse system efficiency) | % | 100% | 0.95 | 0.05 |
| Volume of Runoff Reused per ML of Reuse System Capacity | ML/ML | 8.1 | 6.1 | 2.0 |

### *6.2 Costs*

To calculate the cost per ML for re-use systems the LM component of the Murray Darling Basin Drainage Evaluation Spreadsheet Model (DESM)[26] was used as a guide. Table 9 lists the assumptions used in the model:

**Table 9 - Re-Use Cost Assumptions**

| | |
|---|---|
| Total Capital Cost | $20,000 |
| Annual Cost ($/annum) | $500 |
| Area Serviced (ha) | 107 |
| Irrigation Intensity (ML/ha) (Dairy) | 10 |
| Irrigation Intensity (ML/ha) (Mixed) | 2 |
| Runoff factor | 15% |
| System Efficiency | 80% |

The NPV was calculated per ML for each enterprise over 30 years using a discount rate of 8%. This takes into consideration the capital cost, annual operation and maintenance costs and the amount of water re-used per year. The result was amortised (using an amortisation factor of 0.0888) and divided by the amount of water re-used each year.

The result is a cost per ML of $54. See Appendix 1 for the NPV calculations used listing all the inputs and the results.

To calculate the cost per kg of phosphorus, per kg salt or per kg suspended solids the following calculation was used:

The cost of a re-use system per ML of water is $54 where 0.85kg of phosphorus per ML exists, or:

y = 1/x

y = 1/0.85

y = 1.18

1.18*54 = $63/kg P.

Therefore where 1kg of phosphorus exists in a ML of water the cost is $63.

[26] MDBC (1995), *Drainage Evaluation Spreadsheet Model,* Murray Darling Basin Commission

Where other parameter loads exist (e.g. Swan Hill catchment P = 0.10kg, salt = 420kg) the corresponding load was simply substituted in the calculation as x to calculate the factor described above as y.

In terms of the public versus private benefit the current cost share for re-use systems in the LMIRSWMIP is recommended to be 85% Government and 15% landowner in the Barr Creek catchment and 50% Government and 50% landowner in all other catchments. Therefore these splits could be used in the tables if private versus public costs need to be calculated.

# 7. Nutrient Reduction Re-use System

## *7.1 Assumptions*

Nutrient reduction reuse systems (NRRS) are considered in catchments where outfall via a Surface Water Management System (SWMS) is not available.

A NRRS in the North Central Catchment will retain up to 25ML of rainfall runoff annually. However, as a NRRS will generally be associated with an irrigation reuse system (i.e. water retained in a reuse system will be passed through a NRRS), the total volume reused considers the volume reused from the irrigation reuse systems (40ML annually) in addition to the rainfall runoff which will be reused. As the water captured in a NRRS will be direct runoff from irrigated landuse, the water quality concentration in a NRRS has been based on on-farm concentrations i.e. 0.85 mg/l.

## *7.2 Costs*

To calculate the cost per ML for NRRS the LM component of the Murray Darling Basin Drainage Evaluation Spreadsheet Model (DESM)[27] was used as a guide. Table 12 lists the assumptions used in the model:

**Table 10 - NRRS Cost Assumptions**

| | |
|---|---|
| Total Capital Cost | $61,000 |
| Annual Cost ($/annum) | $500 |
| Area Serviced (ha) | 100 |
| Water saved per year (ML) | 25 |

The NPV is calculated per ML over 30 years using a discount rate of 8%. This takes into consideration the capital cost, annual operation and maintenance costs and the amount of water re-used per year. The result was amortised (using an amortisation factor of 0.0888) and divided by the amount of water re-used each year.

The result is a cost per ML of $86. See Appendix 2 for the NPV calculations used listing all the inputs and the results.

To calculate the cost per kg of phosphorus, per kg salt or per kg suspended solids the following example calculation was used:

The cost of a NRRS per ML of water is $86 where 0.85kg of phosphorus per ML exists, or:

$y = 1/x$

$y = 1/0.85$

$y = 1.18$

1.18*$86 = $101/kg P

[27] Murray Darling Basin Commission (1995), *Drainage Evaluation Spreadsheet Model,* Murray Darling Basin Commission

Therefore where 1kg of phosphorus exists in a ML of water the cost is $101.

Where other parameter loads exist (e.g. Swan Hill catchment P = 0.10kg, salt = 420kg) the corresponding load was simply substituted in the calculation as x to calculate the factor described above as y.

In terms of the public versus private benefit the current cost share for NRRS in the LMIRSWMIP is effectively 50% Government and 50% landowner. Therefore this split could be used in the tables if private versus public costs need to be calculated.

# 8. Drainage Diversion (high flow)

## *8.1 Assumptions*

High flow diversions are drainage waters that, under a G-MW Agreement, are diverted from regional surface water management systems under high flow conditions and placed in a storage for later use. The volumes of water diverted are generally not metered but can be determined by establishing the number of times and the extent of storage refills, as recorded by the regional surface water management system managers.

The assumptions used for drainage diversion have been taken from actual cases associated with the Drainage Diversion Nutrient Removal Incentive Scheme in the Goulburn-Broken catchment[28], these are shown in Table 11. It is assumed that every 1ML of water diverted equates to 1.5ML of water being diverted from the drainage system.

Drainage diversion is categorised as a system capable of diverting drainage flows to a storage with a capacity greater than 25ML. This distinguishes them from NRRS which are limited to volumes of less than 25ML.

**Table 11 - Drainage Diversion Characteristics**

| Drainage Diversion >25ML | |
|---|---|
| Average size (ML) | 200 |
| Times filled per year | 1.5 |
| Volume used per season (ML) | 300 |
| Area serviced (ha) | 130 |

## *8.2 Costs*

To calculate the cost per ML for Drainage Diversion (High Flow) the LM component of the Murray Darling Basin Drainage Evaluation Spreadsheet Model (DESM)[29] was used as a guide. Table 12 lists the assumptions used in the model:

[28] Ockerby, K. (November 2005), Department of Primary Industries, *Pers. Comms.*

[29] Murray Darling Basin Commission (1995), *Drainage Evaluation Spreadsheet Model,* Murray Darling Basin Commission

**Table 12 - Drainage Diversion (High Flow) Cost Assumptions**

| | |
|---|---|
| Total Capital Cost | $161,000 |
| Annual Cost ($/annum)* | $3,300 |
| Area Serviced (ha) | 100 |
| High Flow Drainage Diversion Storage Capacity | 200 |
| Water saved per year (ML) | 300 |

* Annual cost (O&M) extrapolated from the re-use O&M costs (6.6 times more water diverted and used by high flow diversion systems therefore it is assumed that O&M costs are 6.6 times greater).

The NPV is calculated per ML over 30 years using a discount rate of 8%. This takes into consideration the capital cost, annual operation and maintenance costs and the amount of water re-used per year. The result was amortised (using an amortisation factor of 0.0888) and divided by the amount of water re-used each year.

The result is a cost per ML of $55. See Appendix 3 for the NPV calculations used listing all the inputs and the results.

To calculate the cost per kg of phosphorus, per kg salt or per kg suspended solids the following example calculation was used:

The cost of a high flow diversion systems per ML of water is $55 where 0.29kg of phosphorus per ML exists, or:

y = 1/x

y = 1/0.29

y = 3.45

3.45*55 = $190/kg P

Therefore where 1kg of phosphorus exists in a ML of water the cost is $190.

Where other parameter loads exist (e.g. Swan Hill catchment P = 0.10kg, salt = 420kg) the corresponding load was simply substituted in the calculation as x to calculate the factor described above as y.

# 9. Drainage Diversion (low flow)

## *9.1 Assumptions*

Low flow diversions are drainage waters that, under a G-MW Agreement, are diverted from regional surface water management systems under low flow conditions for immediate use in irrigation. Low flow diversions are metered and have a maximum volume of water allocated to them. Every 1ML of entitlement used therefore equates to 1ML of water being diverted from the drainage system. The volume of water diverted can be determined from the meter readings taken by G-MW.

The G-MW Diversion Agreement states that the water must be pumped and used, that is, it is not to be stored, thus separating low flow drainage diversion from the irrigation re-use systems and high flow diversion systems.

## *9.2 Costs*

This system is effectively a pump and pipe connected to a regional drain and the farm channel system. The size of the system will have a bearing on the cost but for the purposes of this paper it is assumed that the pump/pipe system will cost approximately $10,500 to set up and $500 to operate and maintain annually, see table 13 for details.

**Table 13 - Drainage Diversion (Low Flow) Cost Assumptions**

| | |
|---|---|
| Pump/motor | $8,000 |
| Pipe | $2,500 |
| Total Capital Cost | $10,500 |
| Annual Cost ($/annum)* | $500* |
| Water saved per year (ML) | 50 |

* Annual cost (O&M) derived from the DESM[30] spreadsheet model cost for operating a re-use system, which is considered an accurate comparison to low flow diversion.

The NPV is calculated per ML over 30 years using a discount rate of 8%. This takes into consideration the capital cost, annual operation and maintenance costs and the amount of water re-used per year. The result was amortised (using an amortisation factor of 0.0888) and divided by the amount of water re-used each year.

The result is a cost per ML of $27. See Appendix 4 for the NPV calculations used listing all the inputs and the results.

To calculate the cost per kg of phosphorus, per kg salt or per kg suspended solids the following example calculation was used:

The cost of a low flow diversion systems per ML of water is $27 where 0.29kg of phosphorus per ML exists, or:

$y = 1/x$

$y = 1/0.29$

$y = 3.45$

$3.45*27 = \$93/kg\ P$

Therefore where 1kg of phosphorus exists in a ML of water the cost is $93.

Where other parameter loads exist (e.g. Swan Hill catchment P = 0.10kg, salt = 420kg) the corresponding load was simply substituted in the calculation as x to calculate the factor described above as y.

## 10. Through flow wetlands (in-line and off-line)

### *10.1 Assumptions*

Wetlands with through flow may be either in-line or off-line. The important factor is the hydraulic retention time and that the wetland is not terminal (i.e. water passed through the wetland returns to the regional surface water management system). The cost will differ between these two wetland types.

The following are the assumptions used to arrive at the details contained in the assumptions tables (Tables 6 and 7):

- Hydraulic retention time is the most important factor in determining the effectiveness of the through flow wetlands. For in-line wetlands it is assumed that the retention time is 0.25 days resulting in a 8% reduction in phosphorus load and 13% reduction in suspended solids load[31]. For off-line wetlands the retention time is assumed to be 10 days resulting in a 50%

[30] MDBC (1995), *Drainage Evaluation Spreadsheet Model,* Murray Darling Basin Commission

[31] Department of Land & Water Conservation New South Wales (1998), *The Constructed Wetland Manual,* Volume 2, Department of Land & Water Conservation New South Wales

reduction in phosphorus load and 70% reduction in suspended solids load (see appendix 7 and 8)[32].

- The following was sourced from G-MW, Land and Water Australia project — Nutrient Removal from Rural Drainage Systems Using Wetlands[33];
  - For through flow wetlands (in-line) the nutrient removal was only achieved during low flows (<2.5ML/day), when flows exceeded this the wetland became an exporter of nutrients. Therefore the values captured in the table are only relevant for low flows and should be discarded for flows >2.5ML/day.
  - The trial wetland was constructed in a drain with a capacity of 100ML/day.
- For wetlands off-line it is assume that they exist in the lower parts of catchments, are close to SWMS and do not require revegetation works. Therefore very little is required to have them connected to the system (i.e. some structures and earthworks will be all that is required).

## *10.2 Costs*

### *10.2.1 In-line Wetlands*

The cost per kg of phosphorus removed using wetlands (in-line) was calculated to be $3,495/kg P/yr. NPV calculations are detailed in Appendix 5. Table 14 depicts the cost assumptions used[34].

**Table 14 - Through Flow Wetland (In-Line) Cost Assumptions**[35]

| Item | Cost |
|---|---|
| Earthworks | $40,000 |
| Structures | $30,000 |
| Vegetation | $10,000 |
| Total | $80,000 |
| Annual O&M | $925 |

Based on the capital costs in Table 14 and the following assumptions a NPV calculation was performed:

- the average phosphorus reduction from the Nutrient Removal from Rural Drainage Systems Wetlands report[36] was 0.14kg P/day. This equates to an annual phosphorus reduction of 51.1kg P/yr (i.e. 0.14*365).

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[32] Department of Land & Water Conservation New South Wales (1998), *The Constructed Wetland Manual,* Volume 2, Department of Land & Water Conservation New South Wales

[33] Goulburn-Murray Water (December 2005), *Land and Water Australia Project GMW6, D118 – Nutrient Removal from Rural Drainage Systems Using Wetlands, Final Report,* Goulburn-Murray Water, Tatura

[34] Goulburn-Murray Water (December 2005), *Land and Water Australia Project GMW6, D118 – Nutrient Removal from Rural Drainage Systems Using Wetlands, Final Report,* Goulburn-Murray Water, Tatura

[35] Goulburn-Murray Water (December 2005), *Land and Water Australia Project GMW6, D118 – Nutrient Removal from Rural Drainage Systems Using Wetlands, Final Report,* Goulburn-Murray Water, Tatura

[36] Goulburn-Murray Water (December 2005), *Land and Water Australia Project GMW6, D118 – Nutrient Removal from Rural Drainage Systems Using Wetlands, Final Report,* Goulburn-Murray Water, Tatura

- the NPV is calculated over 30 years at a discount rate of 8%.

The result was a NPV of $90,413. The result was amortised (using an amortisation factor of 0.0888) and divided by the annual amount of water (100ML) that passes through the wetland with a hydraulic retention time of 0.25 days or greater.

The result is a cost of $80 per ML of drainage water passing through the in-line wetland with a hydraulic retention time of 0.25 days or greater. See Appendix 5 for the NPV calculations used listing all the inputs and the results.

Through flow wetlands (in-line) only reduce the loads of phosphorus and suspended solids by 8% and 11% respectively[37]. To account for this the actual reduction in load was calculated for each catchment based on the known load in each catchment (i.e. 8% of the Barr Creek load (0.85kg/ML) is 0.068kg/ML).

To calculate the corresponding cost the following calculation was used, (Barr Creek phosphorus reduction = 0.068kg/ML):

y = 1/x

y = 1/0.068

y = 14.71

14.71*$80 = $1,176/kg P

Therefore where 1kg of phosphorus exists in a ML of water the cost is $1,176.

#### *10.2.2 Off-line Wetlands*

To calculate the cost per ML for through flow wetlands (off-line) the LM component of the Murray Darling Basin Drainage Evaluation Spreadsheet Model (DESM)[38] was used as a guide. Table 15 lists the assumptions used in the model:

**Table 15 - Through Flow Wetland (Off-Line) Cost Assumptions[39]**

| Item | Cost |
|---|---|
| Earthworks | $5,000 |
| Structures | $25,000 |
| Total Capital Cost | $30,000 |
| Annual O&M | $1,000 |
| Water diverted (ML/yr) | 100 |
| Assumed Efficiency | 95% |

The NPV is calculated per ML over 30 years using a discount rate of 8%. This takes into consideration the capital cost and the annual operation and maintenance costs. The result was amortised (using an amortisation factor of 0.0888) and divided by the amount of water (100ML) that is assumed to pass through the wetland with a hydraulic retention time of 10 days or greater.

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[37] Goulburn-Murray Water (December 2005), *Land and Water Australia Project GMW6, D118 – Nutrient Removal from Rural Drainage Systems Using Wetlands, Final Report,* Goulburn-Murray Water, Tatura

[38] Murray Darling Basin Commission (1995), *Drainage Evaluation Spreadsheet Model,* Murray Darling Basin Commission

[39] Walters, C. (September 2006), Goulburn-Murray Water, *Pers. Comms.*

The result is a cost of $37 per ML of drainage water passing through the off-line wetland with a hydraulic retention time of 10 days or greater. See Appendix 6 for the NPV calculations used listing all the inputs and the results.

It has been assumed that through flow wetlands (off-line) have a retention time of greater than 10 days thus they reduce the loads of phosphorus and suspended solids by 50% and 70% respectively[40]. To account for this the actual reduction in load was calculated for each catchment based on the known load in each catchment (i.e. 50% of the Barr Creek load (0.85kg/ML) is 0.145kg/ML).

To calculate the corresponding cost in other catchments where different loads exist (i.e. Barr Creek phosphorus reduction = 0.425kg/ML) the following calculation was used:

y = 1/x

y = 1/0.425

y = 2.35

2.35*37 = $86/kg P

Therefore where 1kg of phosphorus exists in a ML of water the cost is $86.

## 11. Wetlands (Terminal)

### *11.1 Assumptions*

Terminal wetlands receive water diverted from the regional surface water management system. The distinction between these wetlands and those described above is the water entering terminal wetlands does not return to the surface water management system. It is therefore assumed that the salt, suspended solids and phosphorus in the drainage water diverted to these systems is completely and permanently removed from the regional surface water management system.

### *11.2 Costs*

These wetlands are generally naturally occurring and require connection to the surface water management system through the implementation of earthworks and some structures. Therefore, it is expected that the costs to implement these wetlands will be significantly less than that for in-line wetlands. The unit cost will be largely dependant on the capacity of the natural terminal wetland. Therefore, costs will need to be estimated on a case by case basis and have not been considered in this document.

## 12. Impact Of Planned Works

Full implementation of the LMIRSWMIP[41] SWMS (i.e.31 km of primary drains, 367 km of community drains) will result in increased levels of salt, phosphorus and suspended solids entering waterways.

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[40] Goulburn-Murray Water (December 2005), *Land and Water Australia Project GMW6, D118 – Nutrient Removal from Rural Drainage Systems Using Wetlands, Final Report,* Goulburn-Murray Water, Tatura

[41] North Central Catchment Management Authority (January 2004), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Volume 1(Draft),* North Central Catchment Management Authority, Huntly.

Table 16 depicts the information contained in the LMIRSWMIP Downstream Water Quality and Quantity Impacts Technical Background Paper No. V3.1.5[42] and the LMIRSWMIP[43] in relation to SWMS. This information was used to determine the assumed impacts of implementing SWMS.

**Table 16 - SWMS Assumptions**

| Catchment | Drain length (km) | Area serviced (ha) | Area to length (ha/km) | Flow Increase (ML/yr) | Average flow to length (ML/km) | Volumetric generation rate per ha (ML/ha/yr) |
|---|---|---|---|---|---|---|
| Swan Hill | 18 | 1,850 | 103 | 1,000 | 56 | 0.541 |
| Fish Point | 0 | 0 | | -75 | | |
| Koondrook-Benjeroop | 86 | 8,000 | 93 | 2,900 | 34 | 0.363 |
| Kerang Lakes | 12 | 1,880 | 157 | 0 | 0 | 0.000 |
| Barr Creek | 67 | 6,800 | 101 | 500 | 7 | 0.074 |
| Gunbower Island | 0 | 0 | | -500 | | |
| Boort West | 0 | 0 | | | | |
| Wandella Creek | 7 | 440 | 63 | >100 | | 0.000 |
| Loddon | 15 | 1,950 | 130 | 700 | 47 | 0.359 |
| Calivil Creek | 98 | 10,700 | 109 | 600 | 6 | 0.056 |
| Pyramid Creek | 95 | 10,700 | 113 | 300 | 3 | 0.028 |
| | | | | | Average | **0.20** |

The flow increases shown take into consideration actions that reduce flows such as NRRS. Negative values recognise actions implemented under the LMIRSWMIP[44] that reduce current inappropriate outfalls.

Based on the information in Table 16, after allowing for outliers, on average every hectare of newly drained land will generate 0.20ML of additional water in the North Central Catchment. When including this allowance for the impact of new SWMS the average mix of farm Management Actions is assumed to be quarantined and not able to be varied for the catchment directly serviced by the new section of SWMS.

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[42] North Central Catchment Management Authority (September 2003), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Downstream Water Quality and Quality Impacts Technical Background Paper No. V3.1.5,* North Central Catchment Management Authority, Huntly

[43] North Central Catchment Management Authority (January 2004), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Volume 1(Draft),* North Central Catchment Management Authority, Huntly.

[44] North Central Catchment Management Authority (January 2004), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Volume 1(Draft),* North Central Catchment Management Authority, Huntly.

### *12.1 Costs*

The LMIRSWMIP[45] states that it will cost $22,953,000 to implement the SWMS component of the plan. The LMIRSWMIP[46] technical paper V3.1.5[47] states that 42,370 hectares will be drained by implementing the proposed SWMS. This equates to a cost of $541 per hectare.

0.20ML/ha is generated per annum when a drain is constructed and it costs $541/ha for SWMS (as outlined above). The following was used to calculate the cost per ML:

y = 1/x

y = 1/0.20

y = 5

5*541 = $2,705/ML

The SWMS management action does not improve water quality therefore associated costs have not been used in the tables and appear here for information only.

## 13. Output Based

The same process could be used to calculate the cost per output as was used for the outcomes above. However, for ease of calculation the outcome cost for phosphorus, salt and suspended solids was multiplied by the assumed volumetric achievement for each management action (e.g. for irrigation reuse systems the outcome assumed achievements and implementation costs were multiplied by 8.1). For management actions where a multiplication factor does not exist (e.g. for drainage diversion (low flow) every 1ML diverted equates to 1ML of irrigation tail water stopped from entering natural waterways) these have not been repeated in the output tables.

## 14. Management Actions not included

There are a number of other management actions which may have a short or long term impacts that have not been included in this document. This document supports the "Rapid" Management Action DSS[48] and as such focuses on management actions that have relatively significant impacts and which can be quantified relatively easily.

Where possible a measure of the impact of all management actions should be included in the development of any management action plan. As in many cases management actions are very site specific, some of these unquantified management actions and the reasons for their exclusion are as follows:

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[45] North Central Catchment Management Authority (January 2004), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Volume 1(Draft),* North Central Catchment Management Authority, Huntly.

[46] North Central Catchment Management Authority (January 2004), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Volume 1(Draft),* North Central Catchment Management Authority, Huntly.

[47] North Central Catchment Management Authority (September 2003), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Downstream Water Quality and Quality Impacts Technical Background Paper No. V3.1.5,* North Central Catchment Management Authority, Huntly

[48] Department of Sustainability & Environment (December 2005), *IDMOU Rapid Management Action Decision Support System, First Draft*, Hydro Environmental

**(i) Whole Farm Plans**

Although the completion and implementation of whole farm plans will indirectly result in a reduction in water leaving farms, the direct effect will be included in the benefit associated with implementing the various components (management actions) of the plan, particularly irrigation re-use systems. To avoid double counting the benefits of whole farm plans have therefore not been separately accounted for in this paper.

**(ii) Laser Grading and Landforming**

Laser grading and land forming can either increase or decrease tailwater runoff associated with the application of irrigation water, depending upon the pre and post grading land conditions. However in most instances laser grading and land forming is also accompanied by the installation of an associated reuse system. To avoid double counting laser grading and landforming have not been separately accounted for in this paper.

**(iii) Change in irrigation water application method (including irrigation scheduling)**

Changes in irrigation water application method which includes, installation of sprinklers, subsurface drip, centre pivot systems, automation of farm channel systems and the use of irrigation scheduling will lead to changes in the amount of tailwater runoff. Most of these changes in application technique are also often associated with the development of reuse systems. The savings to be achieved by each change will vary significantly from system to system, will be small and difficult to quantify. To avoid double counting and excessive errors it has therefore not been included in this paper.

**(iv) Channel leaks and spills**

Channel leaks and spills are difficult to predict, in addition the quality of the water subjected to leaks and spills is good and therefore the impact in terms of the IDMOU and water quality is not significant. Therefore they have not been included in this document.

**(v) Other management actions**

There are a number of other management actions that have relatively minor impacts on water quality at a regional scale but that have significant local impacts, such as the fencing of drains and streams to exclude stock, grading tracks away from drains and streams and implementing buffer strips. These have not been included due to the relatively minor impacts at a regional scale and the challenges associated with quantifying the impacts.

## 15. Monitoring

Table 17 depicts the proposed information that should be monitored on a catchment basis that will be relevant to the IDMOU DSS process. Some of this information is currently collected by DPI as a component of their grants programs.

**Table 17 - Proposed IDMOU Management Action Monitoring**

| Management Action | Proposed IDMOU Management Action Monitoring | | | | | | Monitoring Unit |
|---|---|---|---|---|---|---|---|
| Reuse Systems (Permanent and Annual Pasture) | Number in each IDMOU Catchment | Location | Capacity (ML) | Farm area serviced by each (ha) | Landuse type serviced by each | | ML/ha (storage volume/irrigated area) |
| Nutrient Reduction Reuse Systems | Number in each IDMOU Catchment | Location | Capacity (ML) | Farm area serviced by each (ha) | Landuse type serviced by each | | ML/ha (storage volume/irrigated area) |
| Wetlands (In-line) | Number in each IDMOU Catchment | Location | Length (m) | Drain cross-section shape | Flow velocity (m/s) | Hydraulic retention time of water passed through per day | % of total drain annual flow volume passed through the wetland with a hydraulic retention time greater than 0.25 days |
| Wetlands (Off-line) | Number in each IDMOU Catchment | Location | Capacity (ML) | Average flow weighted water quality conveyed to wetland (TP, TN, EC, SS) | Hydraulic retention time of water passed through per day | | % of total drain annual flow volume passed through the wetland with a hydraulic retention time greater than 10 days |
| Wetlands (Terminal) | Number in each IDMOU Catchment | Location | Volume (ML) | Average flow weighted water quality in drain (TP, TN, EC, SS) | Volume of water conveyed to the wetland annually (ML) | | ML (volume of terminal wetland storage capacity )<br>% total drain annual flow volume conveyed to the wetland |
| Drainage Diversion (Low Flow) | Number in each IDMOU Catchment | Location | Agreement/ licence volume (ML/yr) | Average flow weighted water quality in drain (TP, TN, EC, SS) | Annual sub-catchment yield (ML) | | % of Agreement entitlement diverted<br>% of average sub-catchment yield allocated as entitlement |

| Management Action | Proposed IDMOU Management Action Monitoring | | | | | | Monitoring Unit |
|---|---|---|---|---|---|---|---|
| Drainage Diversion (High Flow) | Number in each IDMOU Catchment | Location | Capacity (ML) | Average flow weighted water quality in drain (TP, TN, EC, SS) | Annual sub-catchment yield (ML) | | % of Agreement entitlement diverted<br>% of average sub-catchment yield allocated as entitlement |
| New Surface Water Management System | Number in each IDMOU Catchment | Location/ Name/ Number | Length (km) | Area Served | Annual flow at outfall (ML) | Average flow weighted water quality in drain (TP, TN, EC, SS) | ML/yr flow<br>mg/L concentration of water quality parameters<br>kg/yr load of water quality parameters |

## 16. Data Accuracy

To assist in the decision making process it is important that the accuracy of the data being used is known. To assist in this process a generic accuracy designation system was adapted from a system developed by Water Services Association Australia for Urban Benchmarking data[49]. This alpha number system whereby reliability of the source is designated a score between A and D and the accuracy of the data is allocated a score between 1 and 6. Overall the confidence grade is therefore in the range between A1 and D6 (see Appendix 9 and 10).

As a guide this system was then generically applied to each of the management actions presented in this paper and the results are tabulated in Table 18.

**Table 18 - Indicative Data Accuracy for each Management Action**

| Specific Confidence Grades | | | | |
|---|---|---|---|---|
| Re-use (PP) | Re-use (Crop/AP) | NRRS | Wetlands (terminal and through flow in-line and off-line) | Drainage Diversion |
| **B3** | **B3** | **C3** | **C2** | **B2** |

As the source and accuracy of each of the implementation progress monitoring items outlined in Table 17 for each management action are variable this analysis should be undertaken on a catchment basis.

## 17. Specific Catchment Information

This section contains specific catchment information for each of the 11 catchments detailed in the LMIRSWMIP[50]. Table 19 lists these catchments.

**Table 19 - Loddon Campapse Irrigation Area Catchments**

| Catchment Number | Catchment Name |
|---|---|
| 1 | Swan Hill |
| 2 | Fish Point |
| 3 | Koondrook-Benjeroop |
| 4 | Kerang Lakes |
| 5 | Barr Creek |
| 6 | Gunbower Island |
| 7 | Boort West |
| 8 | Wandella Creek |
| 9 | Loddon |
| 10 | Calivil Creek |
| 11 | Pyramid Creek |

The assumptions used to calculate specific catchment information are identical to those detailed previously.

Where flow and salinity values were not available (i.e. Fish Point and Kerang Lakes) the following assumptions and calculation were used:

[49] Water Services Association of Australia (1997), *Reporting Requirements and Definitions Manual*.

[50] North Central Catchment Management Authority (January 2004), *The Draft Loddon Murray Irrigation Region Surface Water Management Implementation Plan – Volume 1(Draft),* North Central Catchment Management Authority, Huntly.

- Flow — 0.382ML/ha/yr (worst case scenario from flow per unit calculations CMPS&F — see section 3)[51]
- Salt — 0.16 t/ha/yr (worst case scenario from salt load calculations CMPS&F — see section 3)[52]

Therefore 0.16 tonnes of salt in 0.382ML, or

y tonnes in 1ML

y = 1/0.382

y = 2.617801

2.617801*0.16 = 0.42 t/ML or 420 mg/L

Therefore where salinity data does not exist it was calculated using the CMPS&F[53] findings, that is it is assumed that 420kg of salt exists in every ML of water.

[51] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

[52] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

[53] Camp, Scott & Furphy (1995), *Koondrook-Murrabit Community Surface Drainage Feasibility Study,* Final Report. Volumes I & II. In association with Price Merrett & Associates, Rendell McGuckian and R. & J. Frankenberg

### *17.1 Swan Hill Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 300kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.18/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.29/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.008kg of P entering natural waterways. (assumes 8% reduction). | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $10,039/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.050kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $733/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.10kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 300kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS entering natural | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | waterways | waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.10kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | $55/ML<br>$551/kg P<br>$0.18/t salt<br>$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.10kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | $27/ML<br>$273/kg P<br>$0.90/t salt<br>$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.10kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 300kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost.
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost(i) to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 2,430kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 780kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.15kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 450kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.02kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 60kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

### *17.2 Fish Point Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 420kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.13/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 420kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.21/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.005kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $16,732/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.03kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $1,222/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.06kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 420kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | waterways | entering natural waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 420kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | \$55/ML<br>\$919/kg P<br>\$0.13/t salt<br>\$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 420kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | \$27/ML<br>\$455/kg P<br>\$0.06/t salt<br>\$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.06kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 420kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost

(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost(i) to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 3,402kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 1,092kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.09kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 630kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.012kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 84kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

### *17.3 Koondrook-Benjeroop Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[i] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 300kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.18/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.29/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.070kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $1,154/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.435kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $84/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.85kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 300kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | waterways | entering natural waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | \$55/ML<br>\$63/kg P<br>\$0.18/t salt<br>\$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | \$27/ML<br>\$31/kg P<br>\$0.09/t salt<br>\$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.85kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 300kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| **Management action** | **Assumed Volume Achievement (per annum)** | **Assumed annual impact on phosphorus (P)** | **Assumed annual impact on salinity** | **Assumed annual impact on suspended solids (SS)** | **Cost(i) to implement ($/1ML of Storage)** |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 2,430kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 780kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 1.27kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 450kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.17kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 60kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

### *17.4 Kerang Lakes Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 420kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.13/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 420kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.21/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.005kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $16,732/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.03kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $1,222/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 420kg of salt entering | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS entering natural waterways | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | | natural waterways | | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 420kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | $55/ML<br>$919/kg P<br>$0.13/t salt<br>$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 420kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | $27/ML<br>$454/kg P<br>$0.06/t salt<br>$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.06kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 420kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost[(i)] to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 0.49kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 3,402kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 1,092kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.09kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 630kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.012kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 84kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

### *17.5 Barr Creek Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 3,463 kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.02/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 3,463kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.02/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.068kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $1,181/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.425kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $86/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.85kg of P | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 3,463kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | entering natural waterways | waterways | entering natural waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 3,463kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | $55/ML<br>$65/kg P<br>$0.02/t salt<br>$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 3,463kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | $27/ML<br>$32/kg P<br>$0.01/t salt<br>$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.85kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 3,463kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost

(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost(i) to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 28,050kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 9,004kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 1.27kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 5,195kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.17kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 693kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

### *17.6 Gunbower Island Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 300kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $53/ML<br>$63/kg P<br>$0.18/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.29/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.068kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $1,181/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.425kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $86/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.85kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 300kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | waterways | entering natural waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | \$55/ML<br>\$65/kg P<br>\$0.18/t salt<br>\$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 300kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | \$27/ML<br>\$32/kg P<br>\$0.09/t salt<br>\$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.85kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 300kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost[(i)] to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 2,430kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 780kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 1.275kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 450kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.17kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 60kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

## *17.7 Boort West Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 2,000kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.03/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.04/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.005kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $16,732/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time >10 days) equates to a decrease of 0.03kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time >10 days) retains 35kg of SS (assumes 70% reduction). | $1,222/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.06kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 2,000kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | waterways | entering natural waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | \$55/ML<br>\$919/kg P<br>\$0.03/t salt<br>\$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | \$27/ML<br>\$455/kg P<br>\$0.01/t salt<br>\$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.06kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 2,000kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost[(i)] to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 16,200kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 5,200kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.09kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 3,000kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.012kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 400kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

## *17.8 Wandella Creek Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 2,000kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.03/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.04/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.005kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $16,732/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.03kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $1,222/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.06kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 2,000kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | waterways | entering natural waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | $55/ML<br>$919/kg P<br>$0.03/t salt<br>$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.06kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | $27/ML<br>$455/kg P<br>$0.01/t salt<br>$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.06kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 2,000kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost[(i)] to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 0.49kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 16,200kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 5,200kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.09kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 3,000kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.012kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 400kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

### *17.9 Loddon Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost[(i)] to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 2,000kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.03/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.04/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) equates to a decrease of 0.006kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time > 0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $14,341/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) equates to a decrease of 0.035kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time > 10 days) retains 35kg of SS (assumes 70% reduction). | $1,047/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.07kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 2,000kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | waterways | entering natural waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.07kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | $55/ML<br>$788/kg P<br>$0.03/t salt<br>$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.07kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 2,000kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | $27/ML<br>$390/kg P<br>$0.01/t salt<br>$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.07kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 2,000kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost[i] to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 16,200kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 5,200kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.105kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 3,000kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.014kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 400kgP entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

## *17.10 Calivil Creek Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost(i) to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 1,862kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.03/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 1,862kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.05/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time >0.25 days) equates to a decrease of 0.006kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time >0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $12,549/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time >10 days) equates to a decrease of 0.04kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time >10 days) retains 35kg of SS (assumes 70% reduction). | $916/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.08kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 1,862kg of salt | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS entering natural | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | entering natural waterways | waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.08kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 1,862kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | $55/ML<br>$689/kg P<br>$0.03/t salt<br>$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.08kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 1,862kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | $27/ML<br>$341/kg P<br>$0.01/t salt<br>$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.08kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 1,862kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

<u>Output based</u>

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost[(i)] to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 15,082kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 4,841kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.12kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 2,793kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.16kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 372kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

## *17.11 Pyramid Creek Catchment*

Outcome based

| Management action | Assumed volumetric achievement (per annum) | Assumed impact on phosphorus (P) | Assumed impact on salinity | Assumed impact on suspended solids (SS) | Cost(i) to implement ($/outcome) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of water reused equates to a decrease of 0.85kg of P entering the drainage system | Every 1ML of water reused equates to a decrease of 1,999kg of salt entering the drainage system | Every 1ML of water reused equates to a decrease of 50kg of SS entering the drainage system | $54/ML<br>$63/kg P<br>$0.03/t salt<br>$1.07/kg SS |
| Nutrient reduction re-use system (NRRS) | Every 1ML of capacity in the NRRS equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water reused equates to a decrease of 0.85kg of P entering natural waterways | Every 1ML of water reused equates to a decrease of 1,999kg of salt entering natural waterways | Every 1ML of water reused equates to a decrease of 50kg of SS entering natural waterways | $86/ML<br>$102/kg P<br>$0.04/t salt<br>$1.73/kg SS |
| Wetlands (in-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time >0.25 days) equates to a decrease of 0.008kg of P entering natural waterways (assumes 8% reduction) | N/A | Every 1ML of low flow drainage water directed through an established in-line wetland (with a hydraulic retention time >0.25 days) retains 6.5kg of SS (assumes 13% reduction). | $10,039/kg P<br>$12.36/kg SS |
| Wetlands (off-line)<br>An example has been provided in this table, refer to Appendices 7 and 8 for further details. | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time >10 days) equates to a decrease of 0.05kg of P entering natural waterways (assumes 50% reduction). | N/A | Every 1ML of low flow drainage water directed through an established off-line wetland (with a hydraulic retention time >10 days) retains 35kg of SS (assumes 70% reduction). | $733/kg P<br>$1.05/kg SS |
| Wetlands (terminal) | N/A | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 0.10kg of P entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 1,999kg of salt entering natural | Every 1ML of water directed to a terminal wetland (reused) equates to a decrease of 50kg of SS | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | waterways | waterways | entering natural waterways | |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.10kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 1,999kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 50kg of SS entering natural waterways | $55/ML<br>$551/kg P<br>$0.03/t salt<br>$1.10/kg SS |
| Drainage Diversion (low flow) | Every 1ML of water used under a drainage diversion agreement equates to 1ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 0.10kg of P entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 1,999kg of salt entering natural waterways | Every 1ML of water used under a drainage diversion agreement equates to a decrease of 50kg of SS entering natural waterways | $27/ML<br>$273/kg P<br>$0.01/t salt<br>$0.55/kg SS |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1ML of water generated through construction of a SWMS increases P entering the drainage system by 0.10kg | Every 1ML of water generated through construction of a SWMS increases salt entering the drainage system by 1,999kg | Every 1ML of water generated through construction of a SWMS increases SS entering the drainage system by 50kg | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

Output based

| Management action | Assumed Volume Achievement (per annum) | Assumed annual impact on phosphorus (P) | Assumed annual impact on salinity | Assumed annual impact on suspended solids (SS) | Cost[(i)] to implement ($/1ML of Storage) |
|---|---|---|---|---|---|
| Irrigation reuse system | Every 1ML of capacity in the re-use system equates to 8.1ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 6.88kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 16,192kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 405kg of SS entering the drainage system | $437/ML |
| NRRS's | Every 1ML of capacity in the re-use system equates to 2.6ML of irrigation tail water stopped from entering the drainage system | Every 1ML of capacity equates to a decrease of 2.21kg of P entering the drainage system | Every 1ML of capacity equates to a decrease of 5,197kg of salt entering the drainage system | Every 1ML of capacity equates to a decrease of 130kg of SS entering the drainage system | $224/ML |
| Drainage Diversion (high flow) | Every 1ML of water used in a drainage diversion agreement equates to 1.5ML of irrigation tail water stopped from entering natural waterways | Every 1ML of water used equates to a decrease of 0.15kg of P entering natural waterways | Every 1ML of water used equates to a decrease of 2,999kg of salt entering natural waterways | Every 1ML of water used equates to a decrease of 75kg of SS entering natural waterways | $82/ML |
| Surface Water Management Implementation (ii) | Every 1 ha of land drained by a SWMS equates to 0.20ML of flow generated | Every 1 ha of land drained by a SWMS equates to an increase of 0.02kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 400kg P entering the drainage system | Every 1 ha of land drained by a SWMS equates to an increase of 10kg P entering the drainage system | Not Relevant as Management Action does not improve water quality |

(i) Present value capitalised cost
(ii) Surface Water Management Implementation will result in a negative impact on water quality and has been provided for information purposes only.

**Appendix 1 - NPV Calculations for re-use systems**

| CALCULATING COST PER ML OF REUSED WATER | | | | |
|---|---|---|---|---|
| | **Earthworks** | **Pump** | **Total Capital Cost** | **Annual Cost ($/annum)** |
| **Irrigation Re-use Systems** | $10,000 | $10,000 | $20,000 | $500 |
| | | | | |
| **Land Use** | **Runoff Reused (ML/year)** | | | |
| **Pasture (Annual and Permanent)** | 40 | | | |
| | | | | |
| **Pasture** | **ML** | **TP** | **SS** | **Salt** |
| **Average Reduction (kg/ML)** | - | 0.85 | 50 | 1,369 |
| **Cost per kg Reduction ($/kg)** | $53.62 | $63.09 | $1.07 | $0.04 |
| | | | | |
| **Discount rate** | | 8% | | |
| **Amortisation factor** | | 0.08883 | | |
| | | | | |
| **Year** | **Capital cost** | **O&M** | **Total cost** | |
| 0 | | 0 | $0 | |
| 1 | $20,000 | $500 | $20,500 | |
| 2 | | $500 | $500 | |
| 3 | | $500 | $500 | |
| 4 | | $500 | $500 | |
| 5 | | $500 | $500 | |
| 6 | | $500 | $500 | |
| 7 | | $500 | $500 | |
| 8 | | $500 | $500 | |
| 9 | | $500 | $500 | |
| 10 | | $500 | $500 | |
| 11 | | $500 | $500 | |
| 12 | | $500 | $500 | |
| 13 | | $500 | $500 | |
| 14 | | $500 | $500 | |
| 15 | | $500 | $500 | |
| 16 | | $500 | $500 | |
| 17 | | $500 | $500 | |
| 18 | | $500 | $500 | |
| 19 | | $500 | $500 | |
| 20 | | $500 | $500 | |
| 21 | | $500 | $500 | |
| 22 | | $500 | $500 | |
| 23 | | $500 | $500 | |
| 24 | | $500 | $500 | |
| 25 | | $500 | $500 | |
| 26 | | $500 | $500 | |
| 27 | | $500 | $500 | |
| 28 | | $500 | $500 | |
| 29 | | $500 | $500 | |
| 30 | | $500 | $500 | |
| | | NPV | $24,147 | |

**Appendix 2 - NPV Calculations for NRRS**

| CALCULATING COST PER ML OF REUSED WATER FOR NRRS | | | | |
|---|---|---|---|---|
| | Earthworks | Pump | Total Capital Cost | Annual Cost ($/annum) |
| **NRRS** | $51,000 | $10,000 | $61,000 | $600 |
| | | | | |
| | **ML** | **TP** | **SS** | **Salt** |
| **Average Reduction (kg/ML)** | - | 0.85 | 50 | 1,369 |
| **Cost per kg Reduction ($/kg)** | $86.42 | $101.67 | $1.73 | $0.06 |
| | | | | |
| **Water Re-used (ML/year)** | | 65 | | |
| **Discount rate** | | 8% | | |
| **Amortisation factor** | | 0.08883 | | |
| | | | | |
| Year | **Capital cost** | **O&M** | **Total cost** | |
| 0 | | 0 | $0 | |
| 1 | $61,000 | $600 | $61,600 | |
| 2 | | $600 | $600 | |
| 3 | | $600 | $600 | |
| 4 | | $600 | $600 | |
| 5 | | $600 | $600 | |
| 6 | | $600 | $600 | |
| 7 | | $600 | $600 | |
| 8 | | $600 | $600 | |
| 9 | | $600 | $600 | |
| 10 | | $600 | $600 | |
| 11 | | $600 | $600 | |
| 12 | | $600 | $600 | |
| 13 | | $600 | $600 | |
| 14 | | $600 | $600 | |
| 15 | | $600 | $600 | |
| 16 | | $600 | $600 | |
| 17 | | $600 | $600 | |
| 18 | | $600 | $600 | |
| 19 | | $600 | $600 | |
| 20 | | $600 | $600 | |
| 21 | | $600 | $600 | |
| 22 | | $600 | $600 | |
| 23 | | $600 | $600 | |
| 24 | | $600 | $600 | |
| 25 | | $600 | $600 | |
| 26 | | $600 | $600 | |
| 27 | | $600 | $600 | |
| 28 | | $600 | $600 | |
| 29 | | $600 | $600 | |
| 30 | | $600 | $600 | |
| | | NPV | $63,236 | |

**Appendix 3 - NPV Calculations for Drainage Diversion (High Flow)**

| CALCULATING COST PER ML OF REUSED WATER DRAINAGE DIVERSION (HIGH FLOW) | | | | |
|---|---|---|---|---|
| | Earthworks | Pump | Total Capital Cost | Annual Cost ($/annum) |
| **Drainage Diversion** | $115,000 | $46,000 | $161,000 | $3,300 |
| | | | | |
| | **ML** | **TP** | **SS** | **Salt** |
| **Average Reduction (kg/ML)** | - | 0.29 | 50 | 1,369 |
| **Cost per kg Reduction ($/kg)** | $55.14 | $190.14 | $1.10 | $0.04 |
| | | | | |
| **Water Re-used (ML/year)** | | 300 | | |
| **Discount rate** | | 8% | | |
| **Amortisation factor** | | 0.08883 | | |
| | | | | |
| **Year** | **Capital cost** | **O&M** | **Total cost** | |
| 0 | | 0 | $0 | |
| 1 | $161,000 | $3,300 | $164,300 | |
| 2 | | $3,300 | $3,300 | |
| 3 | | $3,300 | $3,300 | |
| 4 | | $3,300 | $3,300 | |
| 5 | | $3,300 | $3,300 | |
| 6 | | $3,300 | $3,300 | |
| 7 | | $3,300 | $3,300 | |
| 8 | | $3,300 | $3,300 | |
| 9 | | $3,300 | $3,300 | |
| 10 | | $3,300 | $3,300 | |
| 11 | | $3,300 | $3,300 | |
| 12 | | $3,300 | $3,300 | |
| 13 | | $3,300 | $3,300 | |
| 14 | | $3,300 | $3,300 | |
| 15 | | $3,300 | $3,300 | |
| 16 | | $3,300 | $3,300 | |
| 17 | | $3,300 | $3,300 | |
| 18 | | $3,300 | $3,300 | |
| 19 | | $3,300 | $3,300 | |
| 20 | | $3,300 | $3,300 | |
| 21 | | $3,300 | $3,300 | |
| 22 | | $3,300 | $3,300 | |
| 23 | | $3,300 | $3,300 | |
| 24 | | $3,300 | $3,300 | |
| 25 | | $3,300 | $3,300 | |
| 26 | | $3,300 | $3,300 | |
| 27 | | $3,300 | $3,300 | |
| 28 | | $3,300 | $3,300 | |
| 29 | | $3,300 | $3,300 | |
| 30 | | $3,300 | $3,300 | |
| | | NPV | $186,225 | |

## Appendix 4 - NPV Calculations for Drainage Diversion (Low Flow)

| CALCULATING COST PER ML OF REUSED WATER DRAINAGE DIVERSION (LOW FLOW) | | | | |
|---|---|---|---|---|
| | **Pipe** | **Pump** | **Total Capital Cost** | **Annual Cost ($/annum)** |
| **Drainage Diversion** | $2,500 | $8,000 | $10,500 | $500 |
| | | | | |
| | **ML** | **TP** | **SS** | **Salt** |
| **Average Reduction (kg/ML)** | - | 0.29 | 50 | 1,369 |
| **Cost per kg Reduction ($/kg)** | $27.27 | $94.04 | $0.55 | $0.02 |
| | | | | |
| **Water Re-used (ML/year)** | | 50 | | |
| **Discount rate** | | 8% | | |
| **Amortisation factor** | | 0.08883 | | |
| | | | | |
| **Year** | **Capital cost** | **O&M** | **Total cost** | |
| 0 | | 0 | $0 | |
| 1 | $10,500 | $500 | $11,000 | |
| 2 | | $500 | $500 | |
| 3 | | $500 | $500 | |
| 4 | | $500 | $500 | |
| 5 | | $500 | $500 | |
| 6 | | $500 | $500 | |
| 7 | | $500 | $500 | |
| 8 | | $500 | $500 | |
| 9 | | $500 | $500 | |
| 10 | | $500 | $500 | |
| 11 | | $500 | $500 | |
| 12 | | $500 | $500 | |
| 13 | | $500 | $500 | |
| 14 | | $500 | $500 | |
| 15 | | $500 | $500 | |
| 16 | | $500 | $500 | |
| 17 | | $500 | $500 | |
| 18 | | $500 | $500 | |
| 19 | | $500 | $500 | |
| 20 | | $500 | $500 | |
| 21 | | $500 | $500 | |
| 22 | | $500 | $500 | |
| 23 | | $500 | $500 | |
| 24 | | $500 | $500 | |
| 25 | | $500 | $500 | |
| 26 | | $500 | $500 | |
| 27 | | $500 | $500 | |
| 28 | | $500 | $500 | |
| 29 | | $500 | $500 | |
| 30 | | $500 | $500 | |
| | | NPV | $15,351 | |

## Appendix 5 - NPV Calculations for Wetlands (In-line)

| CALCULATING COST Per kg REDUCTION FOR WETLANDS (INLINE) | | | | | |
|---|---|---|---|---|---|
| | Earthworks | Structure | Vegetation | Total Capital Cost | Annual Cost ($/annum) |
| **In-line Wetland** | $40,000 | $30,000 | $10,000 | $80,000 | $925 |

| | |
|---|---|
| **Discount rate** | 8% |
| **Amortisation factor** | 0.08883 |

| | ML | TP | SS |
|---|---|---|---|
| **Average Reduction (kg/yr)** | | 2 | 650 |
| **Cost per kg Reduction ($/kg)** | $80.31 | $3,494.59 | $12.36 |

| Year | Capital cost | O&M | Total cost |
|---|---|---|---|
| 0 | $80,000 | 0 | $80,000 |
| 1 | | $925 | $925 |
| 2 | | $925 | $925 |
| 3 | | $925 | $925 |
| 4 | | $925 | $925 |
| 5 | | $925 | $925 |
| 6 | | $925 | $925 |
| 7 | | $925 | $925 |
| 8 | | $925 | $925 |
| 9 | | $925 | $925 |
| 10 | | $925 | $925 |
| 11 | | $925 | $925 |
| 12 | | $925 | $925 |
| 13 | | $925 | $925 |
| 14 | | $925 | $925 |
| 15 | | $925 | $925 |
| 16 | | $925 | $925 |
| 17 | | $925 | $925 |
| 18 | | $925 | $925 |
| 19 | | $925 | $925 |
| 20 | | $925 | $925 |
| 21 | | $925 | $925 |
| 22 | | $925 | $925 |
| 23 | | $925 | $925 |
| 24 | | $925 | $925 |
| 25 | | $925 | $925 |
| 26 | | $925 | $925 |
| 27 | | $925 | $925 |
| 28 | | $925 | $925 |
| 29 | | $925 | $925 |
| 30 | | $925 | $925 |
| | | NPV | $90,413 |

**Appendix 6 - NPV Calculations for Wetlands (Off-line)**

| CALCULATING COST Per kg REDUCTION FOR WETLANDS (OFFLINE) | | | | | |
|---|---|---|---|---|---|
| | Earthworks | Structure | Vegetation | Total Capital Cost | Annual Cost ($/annum) |
| Off-line Wetland | $5,000 | $25,000 | $0 | $30,000 | $1,000 |
| | | | | | |
| Discount rate | 8% | | | | |
| Amortisation factor | 0.08883 | | | | |
| | | | | | |
| | ML | TP | SS | | |
| Average Reduction (kg/yr) | | 14 | 3,500 | | |
| Cost per kg Reduction ($/kg) | $36.65 | $255.15 | $1.05 | | |
| | | | | | |
| Year | Capital cost | O&M | Total cost | | |
| 0 | $30,000 | 0 | $30,000 | | |
| 1 | | $1,000 | $1,000 | | |
| 2 | | $1,000 | $1,000 | | |
| 3 | | $1,000 | $1,000 | | |
| 4 | | $1,000 | $1,000 | | |
| 5 | | $1,000 | $1,000 | | |
| 6 | | $1,000 | $1,000 | | |
| 7 | | $1,000 | $1,000 | | |
| 8 | | $1,000 | $1,000 | | |
| 9 | | $1,000 | $1,000 | | |
| 10 | | $1,000 | $1,000 | | |
| 11 | | $1,000 | $1,000 | | |
| 12 | | $1,000 | $1,000 | | |
| 13 | | $1,000 | $1,000 | | |
| 14 | | $1,000 | $1,000 | | |
| 15 | | $1,000 | $1,000 | | |
| 16 | | $1,000 | $1,000 | | |
| 17 | | $1,000 | $1,000 | | |
| 18 | | $1,000 | $1,000 | | |
| 19 | | $1,000 | $1,000 | | |
| 20 | | $1,000 | $1,000 | | |
| 21 | | $1,000 | $1,000 | | |
| 22 | | $1,000 | $1,000 | | |
| 23 | | $1,000 | $1,000 | | |
| 24 | | $1,000 | $1,000 | | |
| 25 | | $1,000 | $1,000 | | |
| 26 | | $1,000 | $1,000 | | |
| 27 | | $1,000 | $1,000 | | |
| 28 | | $1,000 | $1,000 | | |
| 29 | | $1,000 | $1,000 | | |
| 30 | | $1,000 | $1,000 | | |
| | | NPV | $41,258 | | |

**Appendix 7 - Parameter Removal in Wetlands – Generic Curves**

Figure 16-13 Wetland phosphorus removal - generic curve.

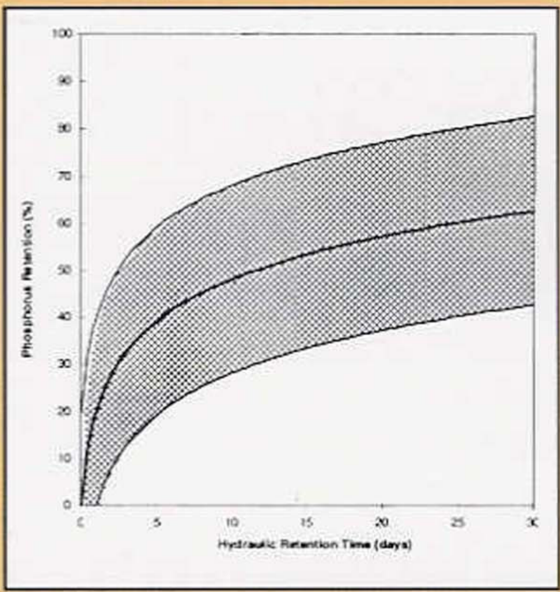


Figure 16-14 Wetland nitrogen removal - generic curve.

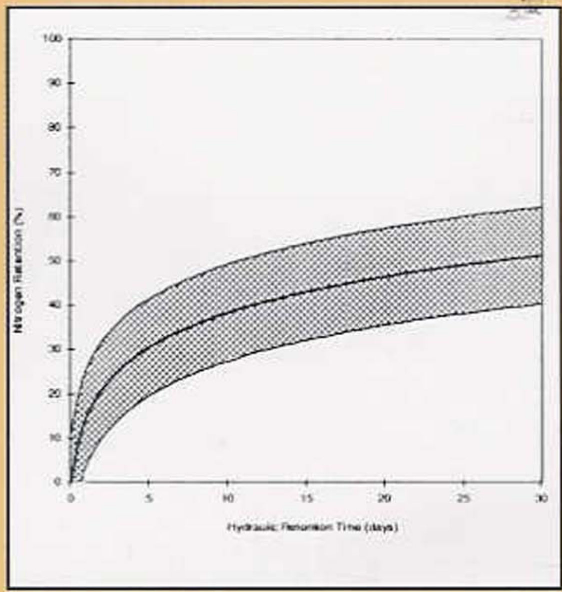
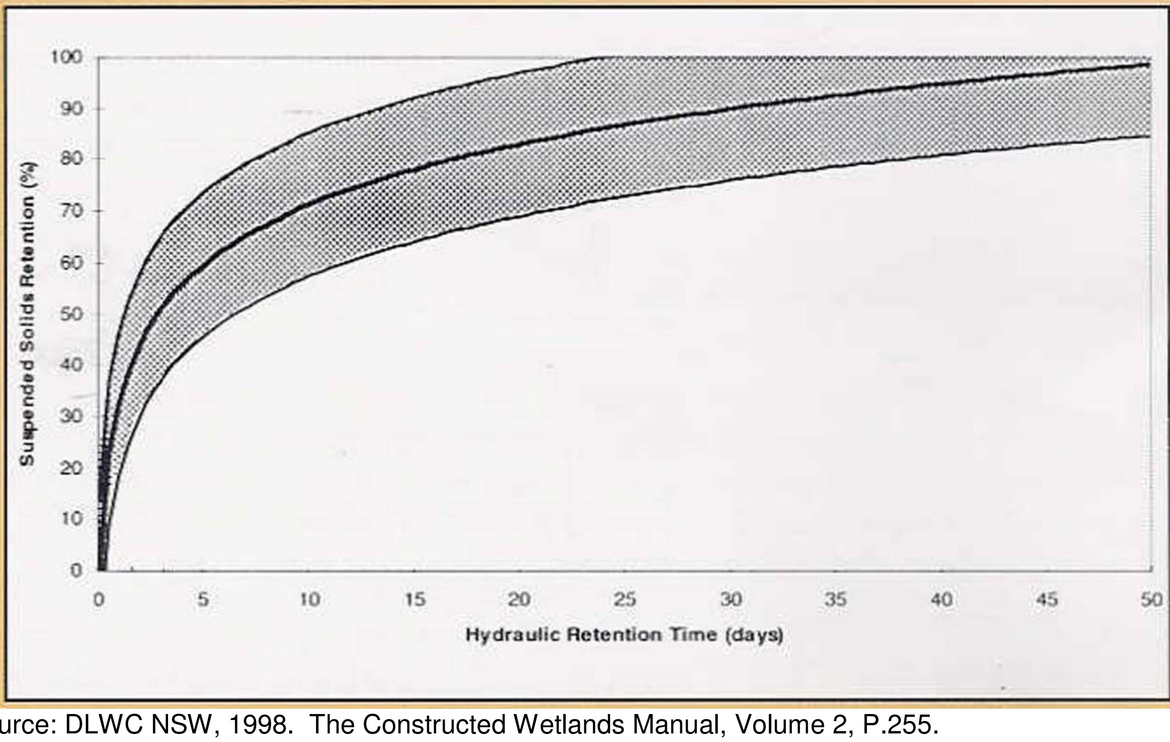


Figure 16-15 Sediment removal - generic curve.




Source: DLWC NSW, 1998. The Constructed Wetlands Manual, Volume 2, P.255.

Parameter removal curves can be used to estimate the long term performance of a wetland. The shaded area represents the variations, which may be caused by such things as soil type, land use, season and parameter concentration. Therefore it is important to recognise that the extrapolation of parameter retention (%) for retentions greater than 0.25 days, as presented in Appendix 8, is only an approximate guide.

**Appendix 8 - Parameter Removal in Wetlands**

| Hydraulic Retention Time (days) | Phosphorus reduction (load and concentration) | Nitrogen reduction (load and concentration) | Suspended Solids reduction (load and concentration) |
|---|---|---|---|
| 0.25 | 8 % | 6 % | 13 % |
| 0.50 | 15 % | 10 % | 25 % |
| 0.75 | 18 % | 13 % | 30 % |
| 1 | 20 % | 16 % | 34 % |
| 2 | 28 % | 22 % | 45 % |
| 3 | 32 % | 26 % | 50 % |
| 10 | 49 % | 38 % | 70 % |

Adapted from: DLWC NSW, 1998. The Constructed Wetlands Manual, Volume 2, P.255.

Irrigation drainage directed through an in-line wetland (with a hydraulic retention time > 0.25 days) results in a reduction in parameter load and concentration. Therefore, catchment segmentation and further assessment is required when calculating the overall impact of a series of wetlands distributed across a catchment.

**Appendix 9 - Confidence Grade Results**

The generic confidence grades and the confidence grades applicable to the proposed Management Action as at November 2005 are shown in the table below. A detailed definition of each of the Reliability and Accuracy Bands is include in Appendix 10.

| Generic Confidence Grades | | | | | Specific Confidence Grades as at November 2005 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Accuracy Band | Reliability Band | | | | Re-use (PP) | Re-use (Crop/AP) | NRRS | Wetland (In-line) | Drainage Diversion |
| | A | B | C | D | | | | | |
| 1 | A1 | | | | | | | | |
| 2 | A2 | B2 | C2 | | | | | C2 | B2 |
| 3 | A3 | B3 | C3 | D3 | B3 | B3 | C3 | | |
| 4 | A4 | B4 | C4 | D4 | | | | | |
| 5 | | | C5 | D5 | | | | | |
| 6 | | | | D6 | | | | | |
| X | AX | BX | CX | DX | | | | | |

## Confidence Grade Definition

1. The Confidence Grade is a combination of the Reliability and Accuracy band, for example:
   - A2 Data is based on sound records etc and estimated to be within +/-5%;
   - C4 Data is based on extrapolation from a limited sample and estimated to be within +/-25%;
   - AX Data is based on sound records etc, but value too small to calculate meaningful accuracy percentages.

2. 'Certain Reliability and Accuracy Band combinations are considered to be incompatible. These are blocked out in the table above.

3. Based on the information provided in Appendix 8 the confidence grades for each Management Action was determined to be as shown in the table above.

**Appendix 10 - Confidence Grades — Generic Reliability and Accuracy Bands for Management Actions**

The following documents the level of confidence for each management action given the assumptions and information used to determine the relationships between the management action and its impact on water quality as at November 2005.

## Reliability Bands

| Reliability Band | Description | Re-use (PP) | Re-use (Crop/AP) | NRRS | Wetland (In-line) | Drainage Diversion |
|---|---|---|---|---|---|---|
| A | Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment. | | | | | |
| B | As 'A' but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation. | X | X | | | X |
| C | Extrapolation from limited sample for which grade 'A' or 'B' is available. | | | X | X | |
| D | Unconfirmed verbal reports, cursory inspections or analysis. | | | | | |

## Accuracy Bands

| Accuracy Band | Accuracy to, or within +/- | But outside +/- | Re-use (PP) | Re-use (Crop/AP) | NRRS | Wetland (In-line) | Drainage Diversion |
|---|---|---|---|---|---|---|---|
| 1 | 1% | | | | | | |
| 2 | 5% | 1% | | | | X | X |
| 3 | 10% | 5% | X | X | X | | |
| 4 | 25% | 10% | | | | | |
| 5 | 50% | 25% | | | | | |
| 6 | 100% | 50% | | | | | |
| X | Accuracy outside +/-100%. Small numbers or otherwise incompatible (see table below) | | | | | | |