



Department of **Agriculture**
Government of **Western Australia**

Targeted assistance to intensive agricultural activities in the Peel-Harvey
Coastal Plain Catchment

Final Report

Due 27/03/06

Department of Agriculture, Western Australia

Contact

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Reporting Requirements

16	Establish a GIS based tracking system, listing all point sources in the catchment and the extent and nature of BMP implementation for each point source.	16/06/05	Provide administrative access to the GIS tracking system files with point source and BMP implementation information.
17	Broker and implement, as first priority, dairy case studies of implementation of BMPs to achieve water quality targets and management benchmarks. As a second priority broker and implement case studies of implementation of BMPs to achieve water quality targets and management benchmarks for other point sources and supporting dairy industries.	13/03/06	Provide final report on case studies of implementation of BMPs to achieve water quality targets and management benchmarks.
18	Prepare a final report that summarises the project and identifies opportunities to address gaps in BMP research for point sources, development and implementation, and opportunities for other voluntary, regulatory, economic and market-based measures to support uptake of point source BMPs.	13/03/06	Provide report.

*The **Final Report** of the project must include summaries of the major activities undertaken by the Organisation, an outline of any demonstration/communication activities undertaken as specified in Item G; and an evaluation of the Project against the following criteria, being the capacity of this Project to:*

- *identify point sources (both animal based and horticultural) in the catchment;*
- *evaluate the relative contributions, nutrient balances and efficiencies of various point sources;*
- *determine the effectiveness of current control systems and revision of licenses;*
- *register point source details and BMP implementation information onto a GIS, web-based tracking system;*
- *provide input into the development of water quality improvement and nutrient use efficiency targets and benchmarks for these industries as part of the WQIP;*
- *identify and/or develop cost-effective management actions for industry sectors;*
- *broker agreements with industry sectors (specifically dairy in this instance)/individual enterprises and develop and implement individual management measures for specific sites;*
- *determine the cost effectiveness of proposed point source management systems;*
- *develop measures of current load and potential for load reduction from management measures;*
- *implement case studies of point source control in dairies; and*
- *support the uptake and adoption of BMPs during the Project Period.*

Demonstration/Communication Activities

The Organisation is to make reasonable endeavours to consult as widely as possible with community and stakeholder interests in the Peel-Harvey catchment, on this project and the proposed agricultural BMPs and mechanisms for their implementation.

In undertaking this project the Organisation shall promote the project as part of a broad strategy including other projects in this series (eg the Targeted Assistance to Intensive Agriculture and Stock Exclusion projects) and the proposed Water Quality Improvement Plan for the Peel Inlet and Harvey Estuary. The relationships between the proposed WQIP, this project and the various interim projects shall be explained and their collective value and potential to improve Peel-Harvey water quality promoted.

Presentations, community events

[Weaver, D. and Summers, R. \(2003\) Introduction to the Coastal Catchments Initiative. Presentation to the Peel Development Commission at PDC Mandurah, 12th September.](#)

Lavell, K. (2004). Introduction to the Coastal Catchments Initiative. Presentation to the Serpentine Jarrahdale LCDC, 21st January.

Lavell, K. (2004). Introduction to the Coastal Catchments Initiative. Presentation to the Coolup LCDC, 2nd February.

Lavell, K. (2004). Introduction to the Coastal Catchments Initiative. Presentation to the Corio Landcare Group, 3rd February.

Lavell, K. (2004). Introduction to the Coastal Catchments Initiative. Presentation to the Harvey River LCDC, 9th February.

[Presentation: Lavell, K. \(2004\). The Coastal Catchment Initiative, Best Management Practices. Peel-Harvey Community Forum. 13 February at Fairbridge.](#)

Lavell, K. (2004). Introduction to the Coastal Catchments Initiative. Presentation to the Dandalup-Murray LCDC, 17th February.

[Robert N. Summers, Kelly Lavell and David M Weaver \(2004\) The Peel-Harvey Coastal Catchments Initiative: an overview of agricultural BMP and intensive agriculture projects. Nutrient Management Forum, Albany WA 5-7 April.](#)

[Presentation: D.M. Weaver, S.D. Neville, R.N. Summers, and M.F. Clarke. \(2004\). Reducing nutrient discharge from agriculture through the implementation of BMPs – how far can we go? Riversymposium August 30 – 3 September 2004, Brisbane.](#)

[Paper: D.M. Weaver, S.D. Neville, R.N. Summers, and M.F. Clarke. \(2004\). Reducing nutrient discharge from agriculture through the implementation of BMPs – how far can we go? Riversymposium August 30 – 3 September 2004, Brisbane.](#)

[Paper: Christian Zammit, Peta Kelsey, Phil Bussemaker, and Rob Summers \(2004\) Modelling catchment processes in the Peel-Harvey basin. Riversymposium August 30 – 3 September 2004, Brisbane.](#)

[Paper: Simon D. Neville, D.M. Weaver, K. Lavell, M.F. Clarke, R.N. Summers, H. Ramsey and J. Grant \(2004\) Nutrient balance case studies of agricultural activities in south west Western Australia. Riversymposium August 30 – 3 September 2004, Brisbane.](#)

[Presentation: Simon D. Neville, D.M. Weaver, K. Lavell, M.F. Clarke, R.N. Summers, H. Ramsey and J. Grant \(2004\) Nutrient balance case studies of agricultural activities in south west Western Australia. Riversymposium August 30 – 3 September 2004, Brisbane.](#)

[Paper: Robert Summers, Mark Rivers, and Martin Clarke. \(2004\) The use of bauxite residue to control diffuse phosphorus pollution in Western Australia – a win-win-win outcome. Riversymposium August 30 – 3 September 2004, Brisbane.](#)

[Presentation: Robert Summers, Mark Rivers, and Martin Clarke. \(2004\) The use of bauxite residue to control diffuse phosphorus pollution in Western Australia – a win-win-win outcome. Riversymposium August 30 – 3 September 2004, Brisbane.](#)

[Paper: Kelly Lavell, Robert Summers, David Weaver, Martin Clarke, John Grant, Simon Neville. \(2004\). An audit of the uptake of agricultural nutrient management practices in the Peel-Harvey catchment. Riversymposium August 30 – 3 September 2004, Brisbane.](#)

[Presentation: Kelly Lavell, Robert Summers, David Weaver, Martin Clarke, John Grant, Simon Neville. \(2004\). An audit of the uptake of agricultural](#)

[nutrient management practices in the Peel-Harvey catchment. Riversymposium August 30 – 3 September 2004, Brisbane.](#)

Lavell, K. and Summers, R. (2004). Seminar to Peel-Harvey Coastal Catchments Initiative Working Group. Peel Development Commission, Mandurah.

[Presentation: Lavell, K., Weaver, D. Summers, R. and Neville, S. \(2004\) Nutrient Balances and Best Management Practices in the Peel-Harvey. CCI workshop Meadow Springs 19th November 2004](#)

[Presentation: Weaver, D., Neville, S., Summers, R., and Clarke, M. \(2004\) Reducing nutrient discharge from agriculture through the implementation of BMPs – how far can we go?. CCI workshop Meadow Springs 19th November 2004](#)

[Paper: Neville, S., Weaver, D., Summers, R. N. and Lavell, K. \(2005\). Farmgate nutrient balances in the South West of Western Australia- an eco-efficiency indicator? Proceeding of Environmental sustainability in practice conference Environmental Institute of Australian and New Zealand \(EIANZ\) Christchurch 29 March-1 April.](#)

[Presentation: Neville, S., Weaver, D., Summers, R. N. and Lavell, K. \(2005\). Farmgate nutrient balances in the South West of Western Australia- an eco-efficiency indicator? Proceeding of Environmental sustainability in practice conference Environmental Institute of Australian and New Zealand \(EIANZ\) Christchurch 29 March-1 April.](#)

[Poster: Weaver, DM and Neville, S \(2005\). Support System for Phosphorus Reduction Decisions. Environmental sustainability in practice conference Environmental Institute of Australian and New Zealand \(EIANZ\) Christchurch 29 March-1 April.](#)

Summers, R., Lavell, K., Weaver, D. and Neville, S. (2005). Findings of the Coastal Catchments Initiative. Presentation to the Peel Harvey Catchment Council 1st April 2005.

[Presentation: Lavell, K., Summers, R., Weaver, D. and Neville, S. \(2005\). Findings of the Coastal Catchments Initiative BMP and nutrient balance surveys. Presentation to the Peel Harvey Catchment Council Forum 1st April.](#)

[Presentation: Weaver, D., Neville, S., Summers, R., and Lavell, K. \(2005\). Findings of the Coastal Catchments Initiative BMP modelling. Presentation to the Peel Harvey Catchment Council Forum 1st April.](#)

[Presentation: Summers, R. and Weaver, D. \(2005\) The Coastal Catchments Initiative and the implications for dairies. Dairycatch Technical Workshop, 26-28 April, Busselton.](#)

[Presentation: Summers, R., Lavell, K. and Weaver, D. \(2005\) Peel Development Commission briefing on findings of the Coastal Catchment Initiative and implications for policy and planning. Mandurah 22, April.](#)

[Presentation: Weaver, D. M. and Summers, R. N. \(2005\) The Coastal Catchments Initiative. Presentation to the EPA, 5 May 2005.](#)

[Presentation: Lavell, K. and Summers, R., \(2005\) Peel Development Commission board briefing on findings of the Coastal Catchment Initiative and implications for development in the region. Mandurah 22 June.](#)

[Presentation: Lavell, K., Weaver, D. M. and Summers, R. N. \(2005\) The Coastal Catchments Initiative. Presentation at Parliament House, 30 June 2005.](#)

Steward, K. Weaver, D. and Lavell, K (2005) Demonstration of the GIS BMP tracking tool, Department of Agriculture, South Perth 30th June 2005.

[Presentation: Lavell, K. and Summers, R. \(2005\) CCI and the Impact of Dairying. Presentation to the Greener Pastures project meeting Vasse Research Station 29th July.](#)

Summers, R., Lavell, K., Weaver, D. and Neville, S. (2005) Implications of the findings of the Coastal Catchments Initiative, Presentation at Don Randall's office, Armadale, 5th August.

[Presentation: Summers, R., Lavell, K. and Weaver, D. \(2005\) Implications of the findings of the Coastal Catchments Initiative, Presentation to Federal politicians. 5th July 2005.](#)

[Presentation: Robert Summers \(2005\). Nutrient management research in the Department of Agriculture, Broadacre systems research - environmental focus. Seminar to the Agricultural Research Institute, UWA, 19th August 2005.](#)

[Presentation: Summers, R.N., Lavell, K., Weaver, D. M., Robb, M and Zammit, C. \(2005\). The Coastal Catchments Initiative. Presentation at Williams to South West Catchments Council. 29 August.](#)

[Poster: Kelly Lavell, Robert Summers, David Weaver, Martin Clarke, John Grant, Simon Neville \(2005\). Environmental best practice in the Peel-Harvey Catchment. Poster at NRM Conference, Denmark 4-6 October.](#)

[Poster: David Weaver and Simon Neville \(2005\). Support System for Phosphorus Reduction Decisions. Poster at NRM Conference, Denmark 4-6 October.](#)

Neville, S., Weaver, D., Summers, R. N. and Lavell, K. (2005). Farmgate nutrient balances in the South West of Western Australia- an eco-efficiency indicator? Proceedings of NRM Conference, Denmark 4-6 October.

[Presentation: Neville, S., Weaver, D., Summers, R. N. and Lavell, K. \(2005\). The farmgate nutrient balance – a tool to understand nutrient use efficiency. Presentation to NRM Conference, Denmark 4-6 October.](#)

[Presentation: Kelly Lavell, David Weaver, Robert Summers, Simon Neville and Martin Clarke\(2005\) The WA Coastal Catchment Initiative Projects – how effective can EMS be? 4th National Environmental Management Systems in Agriculture Conference, Beechworth, Victoria October 16-20th October](#)

[Presentation: Neville, S., Weaver, D., Summers, R. N. and Lavell, K. \(2005\). SSPRED-support system for phosphorus reduction decisions, Presentation at Denmark NRM Conference 4-6 October.](#)

Zammit, C., Summers, R. and Lavell, K. (2005) Findings from modelling of the Peel-Harvey estuary and implications for the Geographe Bay. Seminar at Geocatch seminar room, Busselton 10 November.

[Presentation: Zammit C. and Summers R. \(2005\). Modelling catchment processes in the Peel-Harvey basin. Coastal Catchments Conference, Mandurah, Nov 16-18.](#)

[Presentation: Neville, S., Summers, R., Weaver, D. and Lavell, K. \(2005\). Improving water quality in the coastal catchment of the Peel-Harvey. Coastal Catchments Conference, Mandurah, Nov 16-18.](#)

Summers, R., Lavell, K. Weaver, D. and Neville, S. (2005). Agricultural Land Best Management Practices. Water Quality and Waterways Issues in the Peel Region to shire members. Thursday 17 November, The Cut, Port Bouvard Dawesville.

Zammit, C., Summers, R. and Lavell, K. (2005) Findings from modelling of the Peel-Harvey estuary and implications for the Leschenault. Seminar at South West Development Commission seminar room, P Level Bunbury Tower, Bunbury 24 November.

[Presentation: Weaver, D. \(2006\) Catchment scale nutrient audits. Presentation at a workshop “Accounting for Nutrients National Workshop”. Carlton Crest Hotel, Melbourne, Victoria, 23-24 February 2006](#)

[Presentation: Weaver, D., Summers, R., Neville, S. and Lavell, K. \(2006\) CCI in Peel – Harvey, Agricultural BMPs Results and Gaps. CCI Geographe Vasse meeting. Busselton, Monday 13th March 2006](#)

[Presentation: Weaver, D., Summers, R., Neville, S. and Lavell, K. \(2006\) CCI in Peel – Harvey, Agricultural BMPs Results and Gaps. CCI Swan Canning meeting. Perth, Friday 17th March 2006](#)

[Presentation: Weaver, D., Summers, R., Neville, S. and Lavell, K. \(2006\) Approaches to nutrient budgets – catchments scale. Dairy Catchments Research Workshop, Burnie, Tasmania. 28-30 March 2006](#)

EPA presentations:

Richard Morup (2004) Water Sensitive Urban Design, Briefing to the EPA, Nov 4 2004. In principle endorsement.

Carmel Staniland, Vaughn Cox (2004). Water Quality Improvement Plan status update. Briefing to the EPA. Nov 18.

Carmel Staniland (2005) Water Quality Improvement Plan. Briefing to the EPA. May 19.

Malcolm Robb, Christian Zammit (2005) Aquatic Science Report on the Decision Support System Findings – Phosphorus Targets and Preliminary Best Management Practice Results by Subcatchment. Briefing to the EPA. July 28

John Noonan, Mark Rivers and Ross George (2005) Endorse in general terms the approach for the Department of Agriculture’s Farming to the Future (F4F) accreditation. August 11.

Carmel Staniland (2005) Peel Harvey Catchment Council Approved/Revised Memorandum of Understanding. Sept 8.

Carmel Staniland (2005) Water Quality Status Report – catchment and Department of Agriculture Decision Support modeling findings. December 1.

Two presentations were also made to the WA planning commission by staff of other CCI projects. The WA planning commission has since conferred with the EPA and is convening a meeting with the Directors General of the involved agencies. The Director General of the Department of Agriculture, Western Australia, has been briefed by the CCI group for this meeting.

Project Summary against Workplan

Table 1B: Project Workplan, Time frame and Payments

Stage	Activity	Completion Date	Summary
	Sign Financial Agreement		Completed
1	Appoint Project Officer.	29/08/03	Project Officer appointed
2	Advertise and appoint consultant(s) to undertake audit and identify point source management actions.	30/07/03	Consultants, Ecotones and Associates appointed.
	Progress Report 1 If the Organisation fails to complete any activity or output in Stages 1 or 2 by the completion date, the Organisation will notify the Department in writing within seven days. The Department will take action as necessary in accordance with the Marine and Water Division Project Management Protocol.	30/08/03	
3	Commence auditing agricultural point sources of phosphorus (both intensive animal and horticultural), including: <ul style="list-style-type: none"> ▪ an evaluation of the relative phosphorus contributions, nutrient balances and nutrient use/uptake efficiencies of various point sources; and ▪ an assessment of the effectiveness of current pollution control systems and licensing conditions (where they exist) for point source categories. 	30/09/03	Data capture commenced and nutrient balance framework developed. Framework formalised in a database capture tool.
4	Commence developing environmental management and nutrient export targets and benchmarks for enterprise	31/08/03	Consultants appointed to undertake task

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	categories.		
5	Commence developing a GIS based tracking system, listing all point sources in the catchment and the extent and nature of BMP implementation for each point source.	30/09/03	Preliminary consultations over database and GIS design to track BMP adoption were discussed and an interface proposal for a similar project was provided to indicate the direction taken
	Annual Audited Financial Statement	30/09/03	
6	Commence identifying cost effective management actions according to category of point source enterprise. Provide input to Water Quality Improvement Plan.	31/10/03	Draft non-point source BMP review was provided as the basis for BMP selection; Draft described proposed BMPs and their component parts (eg elements of any treatment train approach), including title, description, instances of application, cost-effectiveness, costs of construction and maintenance (including maintenance regimes), along with investigation and consultation processes employed in identifying BMPs
7	Commence brokering and implementing dairy case studies of implementation of BMPs to achieve water quality targets and management benchmarks.	30/11/03	Negotiations made with DairyCatch project to utilise effluent engineer and further subsidise on-ground works in PHCC
8	Commence assisting DEWCP to establish pollution control licensing arrangements and minimum requirements for agricultural point sources, particularly for those dairies participating in the targeted assistance program (consistent with the Review of Regulations Project).	31/11/03	Assistance commenced
9	Commence preparing extension material for all point source managers on revised licensing provisions and water quality protection requirements.	31/11/03	Preparation commenced
	Progress Report 2 If the Organisation fails to commence any activity or output in Stages 3 to 9 by the reporting date, the Organisation will notify the Department in writing within seven days. The Department will take action as necessary in accordance with the Marine and Water Division Project Management Protocol.	30/01/04	

10	<p>Audit agricultural point sources of phosphorus (both intensive animal and horticultural), including:</p> <ul style="list-style-type: none"> ▪ an evaluation of the relative phosphorus contributions, nutrient balances and nutrient use/uptake efficiencies of various point sources; and ▪ an assessment of the effectiveness of current pollution control systems and licensing conditions (where they exist) for point source categories. 	30/05/04	<p>The nutrient balance model had previously been described along with a consideration of the how different BMPs may intervene in nutrient flowpaths and reduce nutrient surplus for non-point sources. Capture of nutrient balance data delayed by incomplete surveys, however, early results indicate low nutrient use efficiency and high nutrient surplus from many rural pursuits. Land uses show industry specific nutrient balance signatures.</p> <p>The BMP audit process was described, including the recommended numbers of each landuse to be surveyed. A short extension was recommended to audit an additional 20 properties and comply with statistical requirements. Initial results suggest low levels of adoption of the audited BMPs.</p>
11	Develop environmental management and nutrient export targets and benchmarks for enterprise categories.	30/07/04	Targets and benchmarks developed by consultant Strategen
<p>Progress Report 3</p> <p>If the Organisation fails to complete any activity or output in Stages 10 and 11 by the reporting date, the Organisation will notify the Department in writing within seven days. The Department will take action as necessary in accordance with the Marine and Water Division Project Management Protocol.</p>		30/07/04	
<p>Annual Audited Financial Statement</p>		30/09/04	
12	Identify cost effective management actions according to category of point source enterprise. Provide input to Water Quality Improvement Plan.	10/12/04	<p>Outcomes of model scenarios and applicable examples of cost effective sets of actions to achieve anticipated water quality targets in rural catchments were described in draft reports and conference papers. The model interface used to run scenarios was presented. Scenarios show:</p> <ul style="list-style-type: none"> • some BMPs, for example Alkaloam, perennial pastures and fertiliser management, provide both significant nutrient reductions and potentially high economic returns • catchment BMPs (riparian buffers) may be responsible for significant nutrient reductions, but at a high net cost • up to 75% P reductions could be attained with 100% adoption of a wide range of actions, and a net economic benefit (high reduction scenario). Without regulation it is unlikely that such high levels of implementation will be achieved because of the high levels of investment required (~\$60M). • more realistic reductions of around 40% could be achieved with a staged

			implementation of a range of actions over a timeframe of 20 years.
13	Broker and implement dairy case studies of implementation of BMPs to achieve water quality targets and management benchmarks.	10/12/04	Case studies brokered
14	Assist DEWCP to establish pollution control licensing arrangements and minimum requirements for agricultural point sources, particularly for those dairies participating in the targeted assistance program (consistent with the Review of Regulations Project).	10/12/04	Licensing arrangements were brokered between DEWCP and Dairy Australia for dairies participating in the Targeted assistance scheme.
15	Prepare extension material for all point source managers on revised licensing provisions and water quality protection requirements.	10/12/04	Extension material developed in conjunction with Dairy Australia and the Department of Environment and communicated to dairy farmers.
	Progress Report 4 If the Organisation fails to complete any activity or output in Stages 12 to 15 by the completion date, the Organisation will notify the Department in writing within seven days.	17/12/04	
16	Establish a GIS based tracking system, listing all point sources in the catchment and the extent and nature of BMP implementation for each point source.	16/06/05	The reporting interface of systems established to track and report on BMP adoption was described, showing relevant screens and options of the system.
17	Broker and implement, as first priority, dairy case studies of implementation of BMPs to achieve water quality targets and management benchmarks. As a second priority broker and implement case studies of implementation of BMPs to achieve water quality targets and management benchmarks for other point sources and supporting dairy industries.	13/03/06	Dairy case studies were implemented and cost was assessed per unit cow and kg of P.
18	Prepare a final report that summarises the project and identifies opportunities to address gaps in BMP research for point sources, development and implementation, and	13/03/06	

	opportunities for other voluntary, regulatory, economic and market-based measures to support uptake of point source BMPs.		
	<p>Final Report</p> <p>If the Organisation fails to complete any stage, activity or output by the completion date, the Organisation will notify the Department in writing within seven days.</p>	27/03/06	

GIS Based Tracking System

This aspect has been demonstrated to staff from Environment Australia. The following has been reported in stage 14 of the BMP project:

The on-line mapping (viewing) component has been set up to serve the following purposes:

- For users to view location of major features, industries and subcatchments spatially.
- For land holders to locate and identify their property, or property of interest;
- To aid data entry of property BMP data by displaying property features;
- To enhance property characterisation by providing a visual representation of property features which can be used for property planning and siting of future works.

The web map interface map window extends to the area of the Peel Harvey Catchment and allows users to navigate around the region using view tools including zoom in and out, pan, zoom to scale and refresh, and measuring tools.

Broker and Implement Dairy Case Studies

Of the approximately 33 dairies operating in the Peel-Harvey catchment, 19 were surveyed and prior to assistance from this project few had full effluent management systems. Concurrent with this project was a general assistance package for effluent management being run by Dairy Australia and administered through Dairycatch. The cost of effluent management systems were approximately \$20,000 to \$30,000 and assistance of \$4,000 was available through this CCI project. Below are a number of properties that received assistance either through this project and or Dairycatch (still continuing). The cost of implementation of the effluent management system varied because of site specific factors which could be capitalised on such as natural fall in the landscape reducing the need for pumping and the availability of existing irrigation.

Effluent management implementation

CCI ID or Dairycatch	Location	Holding Ponds	Pumps	Trafficable Sump	Travelling Irrigator	Some prior effluent system existing
CCI000020	Pinjarra	Yes	Yes	Yes – non trafficable sump	Yes (Soaker Hose)	Yes
CCI000022	Pinjarra		Yes	Yes	Yes (Stationary Irrigator)	Yes
CCI000118	Harvey		Yes	Yes	Surface irrigation	
CCI000121	Harvey	Yes	Yes	Yes	Surface irrigation	
CCI000049	Harvey	Yes	Yes	Yes	Surface irrigation	Yes
Dairycatch	Harvey	Yes	Yes	Yes	Surface irrigation	Yes
Dairycatch	Harvey	Yes	Yes	Yes	Yes	Yes
Dairycatch	Waroonna		Yes	Yes	Yes	
Dairycatch	Harvey		Yes		Yes	Yes

Although most of the properties had some form of existing effluent management system, there were few with complete systems or with adequately sized systems. All properties which received funding either through Dairycatch or this project had an engineer visit and design an appropriate effluent management system.

The dairy properties surveyed (in the table below) were assessed for nutrient balance and the surplus was calculated to be a total of 79,460 kg of phosphorus and the total from all 33 was estimated to be 138,000 kg surplus. The amount of effluent captured in the effluent ponds was estimated to be less than 10% of the surplus which would be 13,800 kg, however this is at the source and simply comprises a replacement of applied fertiliser (at best). The SSPRED model predicts that a total of 350 kg P currently reaches the estuary from dairy effluent sheds, and hence full management of effluent from these point sources would retain this amount. The cost of phosphorus retention from effluent management systems in dairies was considered in the URS assessment of factors motivating landholders and is tabled below showing that the cost was estimated to be \$200 per cow which translates to about \$30,000 on the median herd size of 150 milkers and this agrees with the upper cost of a typical effluent system noted above. The cost per unit P retained from reaching the estuary is \$2,570 per kg based on 350 kg retained from reaching the estuary and \$30,000 per dairy property.

Dairy properties surveyed

CCI_ID	Total area (ha)	Cleared area (ha)	P Surplus (kg)	Fertiliser (kg P)	Feed (kg P)	Other input (kg P)	Total P input to farm
CCI000053	123.6	111.2	1159	1300	420	0	1720
CCI000054	192	134.4	7849.9	3330	6166	176	9672
CCI000055	262	262	5632	6250	384	0	6634
CCI000049	160	160	3862.2	4640	1232	0	5872
CCI000043	105.4	94.9	2038.5	1371	1400	0	2771
CCI000039	176	167.2	2468	2750	576	0	3326
CCI000037	73.6	72.8	1693.2	2358	565.2	0	2923.2
CCI000036	248	248	12379.7	4175	9280	0	13455
CCI000033	50	45	4619	2220	3120	0	5340
CCI000030	1200	840	5994.1	3808	3860	0	7668
CCI000022	440	418	4816	5670	2140	0	7810
CCI000021	146	144.5	1664.5	1915.2	757.5	0	2672.7
CCI000020	252	244.4	5608.1	4969.2	3050	0	8019.2
CCI000016	270	270	2895.5	3595.5	720	0	4315.5
CCI000057	263	263	5487.8	6255	620.4	0	6875.4
CCI000065	174	165.3	2842.8	3280	380	0	3660
CCI000075	340	299.2	4820.4	4785	1355	0	6140
CCI000102	185	181.3	697	2215	1032	0	3247
CCI000115	350	343	2932.8	3300	336	0	3636

BMP Performance Parameters and Costs From URS final report

BMP Costs and Adoption Profiles	Effluent Mgt L1 - Dairy Shed (per cow)	Effluent Mgt L2 – Piggery (per pig)	Fertilizer Mgt (per Ha)	Redcoat Fertilizer (per Ha)	Alkaloam 10T/ha (per Ha)	Slow Release P Fertilizer (per Ha)	Perennial Pasture (per Ha)	Irrigation Mgt Level 1 (per Ha)	Riparian H 1st order (per Km)	Riparian H 2nd order (per Km)	Riparian H >3rd order (per Km)
Applicable area %	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
P red (%)	90%	65%	10%	50%	50%	50%	30%	25%	20%	20%	20%
Years to max reduction	1	1	3	3	3	3	3	3	10	10	10
Capital/ Opportunity Cost (\$/unit)	200	2000	10	0	194	0	250	1250	6500	6000	5750
Annual Cost (\$/unit)	15	105	2	15	0	20	30	50	150	150	150
Annual Return (\$/unit)	5	20	15	40	40	40	90	100	-100	0	100
NPV (\$/unit)	-\$325	-\$3,059	\$152	\$312	\$304	\$249	\$498	-\$627	-\$9,616	-\$7,869	-\$6,373
PV Capital & Annual Costs (\$,000)	\$387	\$3,309	\$35	\$187	\$194	\$249	\$624	\$1,873	\$7,123	\$7,869	\$7,619
PV Grants / Subsidy (\$,000)	\$243	\$0	\$25	\$187	\$70	\$249	\$125	\$0	\$7,719	\$7,269	\$7,044

Gaps in BMP Research

Communicating findings to landholders

Although the project was only designed to run for a short period a substantial gap has been recognised in the communication of the information developed. The expectation from farmers has been raised by the project and although communication events have been part of the project, only a small number of individuals (less than 5% of those surveyed) have taken the opportunity to attend. The performance of group communication has repeatedly been shown to be less than satisfactory and more costly than simple one-on-one communication such as that carried out in the gathering of the information. This project has shown that it is clearly possible for an individual operator to successfully interview the land managers of over 35% of the area. Many landholders have not been contacted by the Department of Agriculture for over 10 years. Indeed it has been found in this project that there are only 300 land managers that control the majority of the catchment which would require only two or three experienced agricultural extension officers to service them as both a group and individual basis. What has been clearly demonstrated, is the need to have continuous education to maintain practices and to educate newcomers rather than a simple “one-off” project.

Those farmers surveyed expressed their interest in receiving feedback on the information they provided during the survey, especially the nutrient balance information and how they rate compared to other landholders in the catchment. Raising farmer’s awareness through this technique could be very significant and can offer a way of working directly with the farmers in the catchment. As the farmers provided the information used in the nutrient balance calculations, they directly relate to the information and believe what they are being told. Many of the BMPs being recommended including fertiliser management, soil amendments and perennial pastures offer a solution to improving the farmer’s nutrient balance and can also offer an economic return.

Attempts at securing funding for this purpose of revisiting landholders have not been successful at this stage.

Effectiveness of practices to improve water quality

Measuring the effectiveness of BMPs is costly and requires many years of monitoring to avoid seasonal variations and for the impact of the BMPs to become apparent or statistically significant. They also need to be measured at an appropriate scale, such as in small headwater streams. The value of modelling and the recommendations or plans arising from it, is limited without accurate, defensible and locally derived information on the effectiveness of practices. A more systematic approach has been recommended to the WQIP in gathering information on the effectiveness of different practices to improve water quality. This may take the form of developing sites which will be monitored in the long term to form the basis of adaptive management, where the information will provide feedback to management practices as it develops.

Literature existed for a diverse range of management practices however this included a small component of locally derived information on the effectiveness of these practices. Conflicting information on the effectiveness of practices to retain nutrients on the landscape stems from different land use situations, different soil types, farmer management and variations in climate. Whilst the practices are often intuitively going to be effective and can be seen to be measured in other environments, the effectiveness under local conditions is unknown and due to some local unique elements of soil type, landform and climate the validity of using such information can be called into question. An example of this is the significant variation of the effectiveness of fencing and revegetating streams measured on the south coast of Western Australian compared with information derived from a number of overseas and east coast studies. This is likely to be due to the extreme porosity of local soils, different hydrological pathways and chemical forms and the very poor nutrient retention capacity of these soils. There is limited information in the Peel-Harvey on this and the actual effectiveness in the Peel-Harvey may again vary from the data derived on the South Coast due to differences in landform where the South Coast test area had a steeper catchment and was less subject to inundation caused by the flat landscape of the Peel-Harvey. This may or may not have unduly influenced the effectiveness of nutrient retention of this BMP.

Many of the BMPs need to be researched further to provide more accurate local information on how effective each of the BMPs will be at reducing or delaying P loss to waterways. Possibilities exist for post graduate students and honours students to study the effectiveness of BMPs. Additionally the interaction between BMPs needs to be explored to determine how different combinations of BMPs influence nutrient loss.

Strengths and weaknesses

Modelling

Strengths

The use of relatively simple models or decision support systems appear to be successful in generating sufficient interest in how management decisions will impact on costs and water quality. More complex mechanistic modelling is needed to give long term assessments of these impacts.

Weaknesses

Note that this project and the SSPRED modelling were mainly concerned with rural land and were bound to 2003 land use levels:

- No provision was made for climate change.
- Land use is 2003 levels.
- Urban land use was included in base export modeling but only to a limited degree in BMP modeling.

- Costs associated with implementation such as publicity, catchment support staff etc have not been included in BMP cost/benefit figures. An associated report is looking at “implementation measures that support, influence, encourage or require uptake of best management practices for nutrient management” (URS 2005). Additional costs of implementation are discussed there.

Multi-agency partnership

An external third party fund manager made coordination and timing much simpler and effective than conventional piecemeal projects.

The development of a multi-agency approach was seen as enhancing the effectiveness of the project with highly varied strengths from different departments becoming useful. These included a range of technical expertise from land based information coming together with water quality information expertise coming from another department and strong government contacts facilitating the extension of the information to influential members of the community.

Project Evaluation

Evaluation of the Project against the following criteria:

1. *identify point sources (both animal based and horticultural) in the catchment;*
2. *evaluate the relative contributions, nutrient balances and efficiencies of various point sources;*
3. *determine the effectiveness of current control systems and revision of licenses;*
4. *register point source details and BMP implementation information onto a GIS, web-based tracking system;*
5. *provide input into the development of water quality improvement and nutrient use efficiency targets and benchmarks for these industries as part of the WQIP;*
6. *identify and/or develop cost-effective management actions for industry sectors;*
7. *broker agreements with industry sectors (specifically dairy in this instance)/individual enterprises and develop and implement individual management measures for specific sites;*
8. *determine the cost effectiveness of proposed point source management systems;*
9. *develop measures of current load and potential for load reduction from management measures;*
10. *implement case studies of point source control in dairies; and*
11. *support the uptake and adoption of BMPs during the Project Period.*

Identify point sources (both animal based and horticultural) in the catchment

The project successfully identified animal and horticultural point sources in PHCC through:

- land use surveys, existing knowledge, advice from land conservation district group members on land use types, location and owners, and feedback from land conservation district groups when verifying land use maps Through the multi-agency relationship developed by the CCI project, the licensed properties were also reviewed by the Department of Environment and the Department of Agriculture enabling license conditions to be reviewed and practices or nutrient balances to be developed. This enabled an accurate mapping of all licensed properties.

Evaluate the relative contributions, nutrient balances and efficiencies of various point sources

In order to evaluate the relative contributions, nutrient balances and efficiencies of various point sources, it was necessary to undertake nutrient balance assessments of various land uses using standard statistical techniques. The estimates were made following a review of a USEPA document describing these techniques, estimations of sample numbers of different land use classes to deliver specified levels of confidence, and capture of land use data for the PHCC. For most land uses within the catchment, the number surveyed to capture BMP and nutrient balance information would provide 95% confidence that the data captured is within $\pm 20\%$ of the mean value. Hence, there is a high level of confidence that the current reported levels of nutrient balance and use efficiency are within a band 20% either side of the value. Confidence in the information can also be seen to be high based on more than 1/3rd of the catchment area being surveyed.

The relative contributions in the context of the Peel Inlet and Harvey Estuary were then determined through a risk based modelling approach that utilised the nutrient balance information for specific land uses. This catchment context is useful since it identifies particular land uses that present the greatest threat to the downstream waterways, from the viewpoint of the waterways themselves. The information on efficiency also identified inherent, and currently unavoidable characteristics of particular land use systems.

Determine the effectiveness of current control systems and revision of licenses

The BMP audit undertaken in this project provided a qualitative assessment of the effectiveness of current control systems such as ponds for effluent management were. The audit indicated that many ponds either overflowed or leaked, rendering their effectiveness for the purpose to which they were put questionable. This is particularly the case for small unlicensed enterprises such as dairies, but not so for larger licensed enterprises where licenses included requirements such as screens, ponds, lime dosing and reporting. License revision is only likely to be effective for point sources dominated by feed inputs. These systems, in comparison to land and fertiliser based point sources, deliver most of their nutrients via effluent whereas land and fertiliser based systems deliver less than 20% of their nutrient problem as a point source, and license revision would therefore only deal with a small percentage of the problem. However, during this

project, the cooperative audit of existing licenses revealed some shortcomings and revisited some properties that required alterations in the licence conditions.

Register point source details and BMP implementation information onto a GIS, web-based tracking system

This project effectively achieved this outcome, but only in the context of information collected in the BMP audit and nutrient balance case studies. Virtually none of the respondents to these surveys indicated that they would be willing to use an online system to update information on their activities.

Provide input into the development of water quality improvement and nutrient use efficiency targets and benchmarks for these industries as part of the WQIP

This project developed environmental management and nutrient export benchmarks and targets through a tender. The resultant recommended benchmarks and targets were:

- The implementation of BMP’s that result in zero discharge of P from rural point sources
- Development of enterprise nutrient budgets for all rural point sources with the objective of reducing P production loss to “acceptable levels”
- Adoption of appropriate BMP’s by all rural point source enterprises recognised as being effective at reducing P inputs & uncontrolled P loss

These were further developed into industry and location specific nutrient surpluses, and surplus reductions required to achieve targets.

Identify and/or develop cost-effective management actions for industry sectors

Many of the management actions evaluated in this project were significantly generic enough to allow their assessment over a wide range of industries. This provided an opportunity to guide the WQIP in which actions at catchment and sub-catchment scale resulted in the most cost effective solution. These evaluations were undertaken using models built specifically to determine water quality and economic futures from the adoption of particular BMPs.

Broker agreements with industry sectors (specifically dairy in this instance)/individual enterprises and develop and implement individual management measures for specific sites

This project worked closely alongside the DairyCatch project and leveraged the opportunity to target dairies within the PHCC with additional funding for on-ground works. The project utilised the framework and processes established under DairyCatch to administer funds in the first instance to dairy effluent management, and secondly to other point source problems in the catchment. Each case study was evaluated and developed with the assistance of an effluent

engineer, and a tailor made solution within the limit of funds for each was developed.

Determine the cost effectiveness of proposed point source management systems.

This was difficult and influenced by time constraints in the project, and also complicated by the case by case basis on which effluent management systems are developed and implemented. The project was not sufficiently long to allow implementation and evaluation of installed works to occur. Individual management systems do exist for specific point sources, and these could be evaluated for cost effectiveness if access to confidential information over the costs of systems, and appropriate water quality data was freely available.

Develop measures of current load and potential for load reduction from management measures

This project used a modelling approach to estimate current nutrient loads using a risk based approach that incorporated source, transport and delivery components. The models also estimated nutrient reductions from the adoption of BMPs, the effectiveness of which was estimated from experimental and/or published work. The model utilised in this project is a lumped, annual averaged, static model and is unable to forecast future loads without updating land use and nutrient surplus data. In that context the measures of current load are as current as the data supporting that estimate. Nutrient reduction estimates are also constrained by assuming annual average conditions for nutrient delivery, and hence BMP performance.

Implement case studies of point source control in dairies

This project worked closely alongside the DairyCatch project and leveraged the opportunity to target dairies within the PHCC with additional funding for on-ground works. The project utilised the framework and processes established under DairyCatch to administer funds in the first instance to dairy effluent management, and secondly to other point source problems in the catchment. Each case study was evaluated and developed with the assistance of an effluent engineer, and a tailor made solution within the limit of funds for each was developed.

Support the uptake and adoption of BMPs during the Project Period

This is difficult to evaluate despite the fact that one would assume that the web based GIS BMP tracking tool would allow this evaluation simply. This is not the case for several reasons. These include:

- Development of the tool only concluded near the close of the project
- Making use of the tool requires either landholder input of BMP data through a secure internet connection, or an additional survey to capture and input that data

- Landholder input of BMP data is unlikely to occur as indicated by responses in our surveys where only a very small percentage indicated they would do this.
- Additional surveys have not been undertaken due to fund and time limitations, and other project obligations
- A major BMP recommended in the project, Alkaloam, is currently unavailable due to restrictions on its release imposed by the supplier. Even if landowners wished to use this product, they couldn't because of this restriction. Similar restrictions in the availability of fertilisers with lower water-solubility are also being experienced.

Despite these constraints the project supported the uptake and adoption of BMPs for the project duration.