



Australian Government



**Queensland
Government**
**Environmental
Protection Agency**

Scoping Study on a Nutrient Trading Program to Improve Water Quality in Moreton Bay



Australian Government



**Queensland
Government**
**Environmental
Protection Agency**

Under the national Coastal Catchments Initiative, the Australian and Queensland Governments are investigating the feasibility of using nutrient trading options between sources in Moreton Bay catchments to obtain water quality targets cost-effectively. Stage 1, a feasibility study, is now completed. The findings of Phase 1 show that nutrient trading for Moreton Bay catchments is feasible and offers very encouraging results, with the report identifying suitable catchments and a preferred design scheme. Phase 2 of the project will involve conducting further targeted research, and will design and establish a pilot trading scheme in selected Moreton Bay catchments. Work on Phase 2 is to begin in early 2006.

For further information on this program, please contact:
Economics Branch, Environmental Protection Agency, Tel. (07) 3238 3630

© Australian Government

The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the Australian Government or the Minister for the Environment and Heritage.

While reasonable efforts have been made to ensure that the contents of this publication are factually correct, the Commonwealth does not accept responsibility for the accuracy or completeness of the contents, and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication.

© Environmental Protection Agency

While this report was prepared with care, and is independent advice being given to the EPA, the views expressed are the authors' and do not necessarily reflect those of the Minister for Environment nor the Environmental Protection Agency. The Queensland Government accepts no liability for any decisions or actions taken on the basis of information in this document.

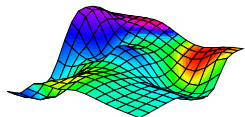
ISBN: 0-9751933-9-2

Report to
Environmental Protection Agency
Queensland Government

Scoping Study on a Nutrient Trading Program to Improve Water Quality in Moreton Bay

Final

11 October 2005



BDA Group
Economics and Environment

MELBOURNE
PO Box 6009
Hawthorn West, VIC 3122
Ph 041 268 7712
Fax (03) 9852 8969

CANBERRA
PO Box 4022
Manuka ACT 2603
Ph (02) 6282 1443
Fax (02) 6161 9310

EXECUTIVE SUMMARY

Ecosystem health within the Ramsar listed Moreton Bay is significantly impacted by poor water quality. There is also poor water quality in several estuaries and catchments that flow into the Bay. The pollutants of greatest concern have been identified as nutrients and sediments.

To meet water quality objectives in the draft 2004 Queensland Water Quality Guidelines, substantial reductions in current pollutant loads will be required. This will be made particularly challenging due to anticipated increases in pollutant loads associated with ongoing development in South East Queensland (SEQ).

The purpose of this study is to scope the potential for trading to deliver lower nutrients or sediments to sensitive waterways in Moreton Bay while reducing environmental management costs. The study forms Phase 1 of a broader project under the Commonwealth's Coastal Catchments Initiative.

Diffuse sources such as stormwater drains and agricultural activities dominate current annual loads of nitrogen, whereas point sources dominate annual phosphorus loads. There are around 60 point sources that are licensed by the Environmental Protection Agency (EPA) - 45 wastewater treatment plants, 10 prawn farms and other industrial activities such as oil refineries, meat works and fertiliser works.

Importantly, pollutants from different sources may have different environmental impacts due to pollutant composition, location, timing of the discharge and the environmental conditions of receiving waters. Understanding the "environmental equivalence" of pollutant loads from different sources is challenging yet integral to the development of robust trading arrangements.

A review of Moreton Bay catchments indicates that over 99 percent of annual sediment loads are from diffuse sources. Accordingly, a sediment trading program would require the introduction of statutory discharge limits on diffuse sources, to create the demand for trading. We believe this would:

- Present significant risks as there is no international experience to draw on;
- Mean much greater difficulty in establishing environmental equivalence, due to uncertainties in estimating sediment generation rates and accounting for spatial, temporal and transport issues in waterways;
- Impose significant costs on regulators and the diffuse sources in identifying current loads, allocating load liabilities, and in monitoring and enforcing compliance; and
- Pose significant stakeholder issues in seeking to introduce regulatory requirements on diffuse and largely rural sources.

For these reasons, the scoping study has focussed on opportunities for nitrogen and phosphorous trading.

Our review of the Moreton Bay catchments also indicated that no single catchment offered a suitable number and mix of pollutant sources that would make nutrient trading attractive. While the grouping of one or more catchments would offer greater “depth” to a nutrient trading market, there were concerns that this would pose over-riding challenges in establishing the environmental equivalence of sources underpinned by hydrodynamic or geographic relationships to support subsequent trading.

Alternatively, our focus shifted to reviewing “clusters” of sub-catchments which were thought to exhibit broad environmental equivalence. Two promising clusters were identified and subject to investigation during a workshop held at EPA on 8th June 2005. The first, centred on the Lower Logan/Albert while the second on Bramble Bay. The initial Bramble Bay cluster was defined as the Pine River Estuary, Cabbage Tree Creek Estuary and Lower Brisbane Estuary, but it was agreed at the workshop to also include a number of additional sources identified in the lower Brisbane and Pine catchments.

The revised Bramble Bay cluster was found to have a greater number and diversity of sources than the Logan Albert cluster. In addition, the seasonal nature of discharges from the most numerous point sources in the Logan Albert cluster (prawn farms) raised complications in determining environmental equivalence, while one source (the Loganholme Waste Water Treatment Plant) was found to dominate overall pollutant loads. Accordingly, the Bramble Bay cluster was chosen as the preferred pilot region, and became the focus of investigations into alternative trading structures.

Trading structures believed best suited to the circumstances of the Bramble Bay cluster and Government’s strategic goals are “point to point” source trading options, preferably with the inclusion of voluntary diffuse source offsets. That is, bubble schemes, permit trading schemes, and either of these incorporating offsets.

There are fourteen point sources of nutrients in the Bramble Bay cluster and seven different responsible entities (Brisbane Water, Pine Rivers Shire Council, Purac Pty Ltd, BP, Caltex, Incitec and Amcor). All are licensed by the EPA and have load limits expressed for nitrogen, but only two have load limits for phosphorous (from 2009). As shown in Table E1, load limits have typically not been constraining, with current load Waste Water Treatment Plant (WWTP) limits for nitrogen some 161 percent of current discharge levels.

There are currently regulatory requirements to reduce nitrogen loads (to constraining levels) at a number of WWTPs, while only Sandgate and Oxley Creek have load limits being introduced for phosphorous from 2009. Under a business as usual scenario there will be pressure for WWTPs to meet future load limits as their volumes of wastewater for treatment increases. Figure E1 compares projected nitrogen discharge loads under a “business as usual” scenario with future load limits at a number of WWTPs. The business as usual scenario takes into account the likely impacts of population growth on nutrient loads, as well as the current WWTP upgrades underway. The figure suggests that even a modest target of holding discharge volumes to 2009 licensed levels would create a significant demand for nutrient trading.

Our investigation of alternative trading structures suggests that a Bubble Licence incorporating the Brisbane Water WWTPs, with provision for voluntary offsets, is likely to provide the most attractive trading structure based on estimated compliance cost savings and a range of strategic factors.

Table E1: Current and regulated nitrogen loads for point sources in Bramble Bay (tonnes)

	2003-04 load	Current load limit	2009 load limit
<i>WWTP</i>			
Sandgate	195	267	46
Nudgee	0.4	1	0.4
Luggage Point	272	562	274
Gibson Island	52	88	91
Fairfield	30	43	12
Oxley Creek	703	1,100	122
Wynnum	70	105	14
Redcliffe	18	No limit	No limit
Murrumba Downs	32	No limit	No limit
Brendale	16	No limit	No limit
<i>Total WWTPs</i>	1,388	2,232 *	625 *
<i>% of 2003-04 WWTP load</i>		161%	45%
<i>Other point sources</i>			
BP	3	13	13
Caltex	5	11	11
Incitec	28	128	128
Amcor	15	40	40

Note: The table is based on dry weather flow – current licensing does not necessarily regulate loads of wet weather discharges

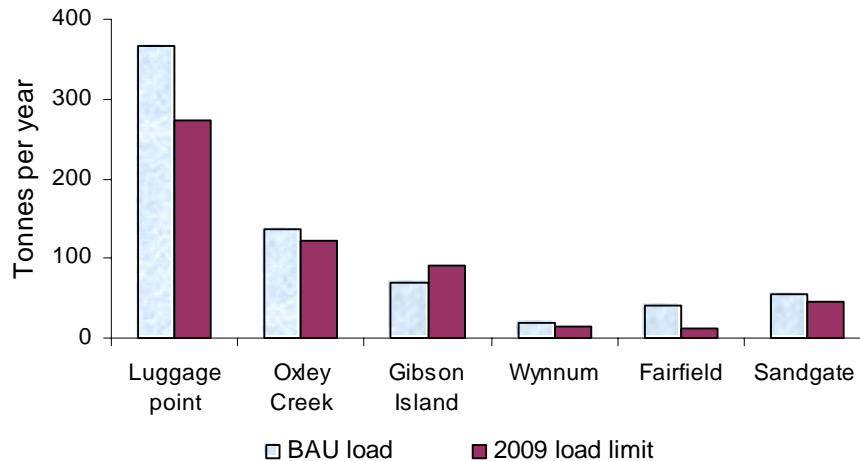
* Assumes discharges from WWTPs with no limit remaining at current levels

The Bubble with offsets approach would provide demonstrable environmental gains as measured by nutrient load reductions. The suggested sources for inclusion in the Bubble represent 25 percent of current nitrogen and 40 percent of current phosphorus loads to Moreton Bay.

The illustrative load targets investigated would, by way of example, lead to a 19 percent and 50 percent reduction in business as usual loads of nitrogen and phosphorus to Moreton Bay from the Bubble sources by 2026. The estimated compliance cost savings in reaching these targets through the Bubble scheme relative to a traditional regulatory approach has been estimated to be around \$65m – an approximate halving in necessary expenditures.

The modest reduction in nitrogen loads is premised on no relaxation in WWTP load limits under the Business As Usual (BAU) scenario, which in the absence of the Bubble scheme may be unlikely and contrary to recent licensing practices where limits have been relaxed due to anticipated WWTP inflows with population growth and development in SEQ.

Figure E1: Comparison between WWTP 2026 nitrogen loads under a “business-as-usual” scenario and relative to 2009 load limits



The Bubble approach also provides a greater likelihood of success, both from a design perspective and likely willingness of Brisbane Water to cooperate in a scheme directed at reducing its compliance costs.

Further, the inclusion of offsets provides an important opportunity to engage diffuse sources in a voluntary way and maximise learning opportunities. It will provide extra compliance flexibility to Brisbane Water and help foster a cultural change away from end-of-pipe solutions. The proposal sits well as a first step in an evolution towards more expansive schemes. Indeed the proposed pilot would start with a similar trading structure to that which has taken some 8-10 years to emerge in South Creek NSW – Australia’s only nutrient trading scheme.

Key design issues for a Bramble Bay Bubble Licence Nutrient Trading Pilot that will need to be addressed in Phase 2 of the Moreton Bay study are canvassed in our report. A broad design framework is presented consistent with the identified strategic, economic and environmental context of the pilot, the recommended pilot area (Bramble Bay) and trading instrument (Bubble Licence). This includes consideration of design principles, the legislative basis to establish trading, the setting of load limits, rules for offset creation, the establishment of environmental equivalences to support trading, trading arrangements and scheme administration.

In conclusion, the scoping study has found that nutrient trading presents a feasible policy instrument to improve water quality in Moreton Bay. The recommended pilot does not seek complexity and may be seen by some as conservative given the current enthusiasm among Australian Governments for market instruments such as emissions trading. Nevertheless, given the mixed history of nutrient trading schemes to date, and the potential benefits that even modest schemes can deliver, we believe the recommended pilot offers a solid first step in this

area, and will provide a valuable learning opportunity and platform for more expansive schemes in the future.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	4
1. INTRODUCTION	11
2. CONCEPTS AND EXPERIENCE WITH NUTRIENT TRADING	12
2.1 Market instruments as policy tools	12
2.2 Range of trading instruments	14
2.3 Experience with nutrient trading in Australia	16
2.4 Experiences with nutrient trading in the US	19
3. NUTRIENT LOADS AND IMPACTS ON MORETON BAY	24
3.1 Environmental goals and water quality management	24
3.2 Current and future nutrient and sediment loads and sources	27
3.3 Environmental equivalence	32
3.4 Excluding sediments from the pilot program	36
4. IDENTIFYING A PILOT REGION	39
4.1 Overview of high feasibility catchments	39
4.2 Review of potential trading “clusters”	44
4.3 Bramble Bay nutrient trading pilot recommended	49
5. DECIDING ON A TRADING STRUCTURE	50
5.1 Identifying a short-list of trading structures	50
5.2 Nutrient abatement costs in Australia	53
5.3 Nutrient abatement in Bramble Bay	55
5.4 Trading benefits of alternative market structures	66
5.5 Bubble licence with offsets trading structure recommended	80
6. POLICY FRAMEWORK AND DESIGN PRINCIPLES	81
6.1 Scheme principles	81
6.2 Legislative basis	82
6.3 Establishing aggregate nutrient load limits	83
6.4 Rules for offset creation	86
6.5 Duty of care or minimum standard	87
6.6 Trading ratios	88
6.7 Trading arrangements	89
6.8 Scheme management and evolution	90

7. KEY ISSUES FOR PHASE 2 OF THE MORETON BAY TRADING STUDY	96
GLOSSARY/ACRONYMS	100
REFERENCES	101
APPENDIX 1: CATCHMENT EVALUATIONS	102
APPENDIX 2: REGULATORY REQUIREMENTS RELATING TO NITROGEN FOR WWTPS IN BRAMBLE BAY	128
APPENDIX 3: COSTS OF NUTRIENT ABATEMENT BY WWTPS	129
APPENDIX 4: TRADE BENEFITS WHERE ENVIRONMENTAL EQUIVALENCE IS LESS THAN 1:1	132

Disclaimer: All surveys, forecasts, projections and recommendations made in reports or studies associated with the consultancy are made in good faith on the basis of information available to the consultants at the time; and achievement of objectives, projections or forecasts set out in such reports or studies will depend among other things on the actions of the Queensland Government and their agents, over which the consultants have no control. Notwithstanding anything contained therein, neither the consulting organisations nor its servants or agents will, except as the law may require, be liable for any loss or other consequences (whether or not due to the negligence of the consultants, their servants or agents) arising out of the services rendered by the consultants.

1. INTRODUCTION

The Queensland Government is seeking to investigate the feasibility of using a trading instrument to reduce nutrients and/or sediments in Moreton Bay. Trading instruments are market-based policy instruments that can facilitate low cost pollution abatement by providing polluting activities access to off-site abatement opportunities. This is achieved through the establishment of a market mechanism with which pollution reduction efforts can be traded to assist liable parties meet statutory pollution discharge limits. Under certain circumstances, they may deliver outcomes faster and at lower cost than more prescriptive measures.

SEQ's coastal regions and waterways are unique and complex ecosystems supporting populations of dugongs and turtles, migratory wading birds and major recreational and commercial fisheries. Scientific research has found that while some catchments and estuaries are in reasonably good condition, there are signs of significant degradation in others and Moreton Bay more broadly, including loss of riparian vegetation, loss of seagrass and algal blooms.

The pollutants of greatest concern have been identified as nutrients and sediments. There are a range of point and diffuse sources contributing to nutrient loads. These include sewage treatment plants, industrial activities, stormwater drains, commercial and residential areas and agricultural activities. As a result of upgrades of sewage treatment plants, diffuse sources are now a greater proportion of total nutrient loads. Once current plant upgrades are complete in 2008, diffuse sources are expected to contribute around 74 percent of nitrogen and 32 percent of phosphorus loads.

The purpose of this study is to scope the potential for trading to deliver lower nutrients or sediments to sensitive waterways in Moreton Bay while reducing environmental management costs. The scoping study forms Phase 1 of a broader project under the Commonwealth's Coastal Catchments Initiative. In Phase 2 of the project the recommended trading instrument and catchment/s will be more fully developed, such that it could be implemented if desired by the Queensland Government.

This report presents:

- An assessment of the feasibility for tradeable discharge rights in Moreton Bay;
- An analysis of possible trading approaches and catchment/s that could support a pilot tradeable discharge rights scheme;
- A recommendation as to the most suitable type of trading instrument and catchment/s for piloting tradeable discharge rights in Moreton Bay; and
- An overview of the policy framework, design principles and issues to be addressed in any subsequent development of an implementation ready pilot scheme.

2. CONCEPTS AND EXPERIENCE WITH NUTRIENT TRADING

This section discusses the use of market-based instruments as policy tools, alternative design approaches for trading schemes, and experiences with nutrient trading in Australia and the US.

2.1 Market instruments as policy tools

Market instruments are policy tools that encourage behaviour through market signals rather than through explicit directives. In this way, governments do not require detailed information on who is best placed to make changes and how, rather this information can be “revealed” by the market.

There is growing interest in market instruments as they can often deliver equivalent outcomes to prescriptive regulatory approaches at lower cost by allowing firms the flexibility to decide on whether to change their actions or incur higher costs. In this way, those firms who face the lowest costs will make the environmental improvements. Accordingly:

... market instruments are best used when there are a range of agents who can make changes, diversity in the means of achieving the environmental outcome, and importantly, where there is significant cost differences between these ways and agents. In these situations, market instruments through the trade of improvement efforts, can “open up” low cost abatement options to deliver environmental gains at lower cost.

Market instruments generally operate as either a price or quantity based instrument, although instruments aimed at improving the operation of existing markets, termed “market-friction” instruments, are sometimes included as market instruments.

Price based instruments assign a price to environmental impacts within existing markets through the imposition of charges, taxes or subsidies. Firms then respond to the modified market signals and adopt the resource use or management practice that offers them the greatest benefit and, if the policy is effective, leads to a better resource management outcome. While these instruments cannot guarantee the *extent* of changes, they act to cap the *costs* incurred under the instrument.

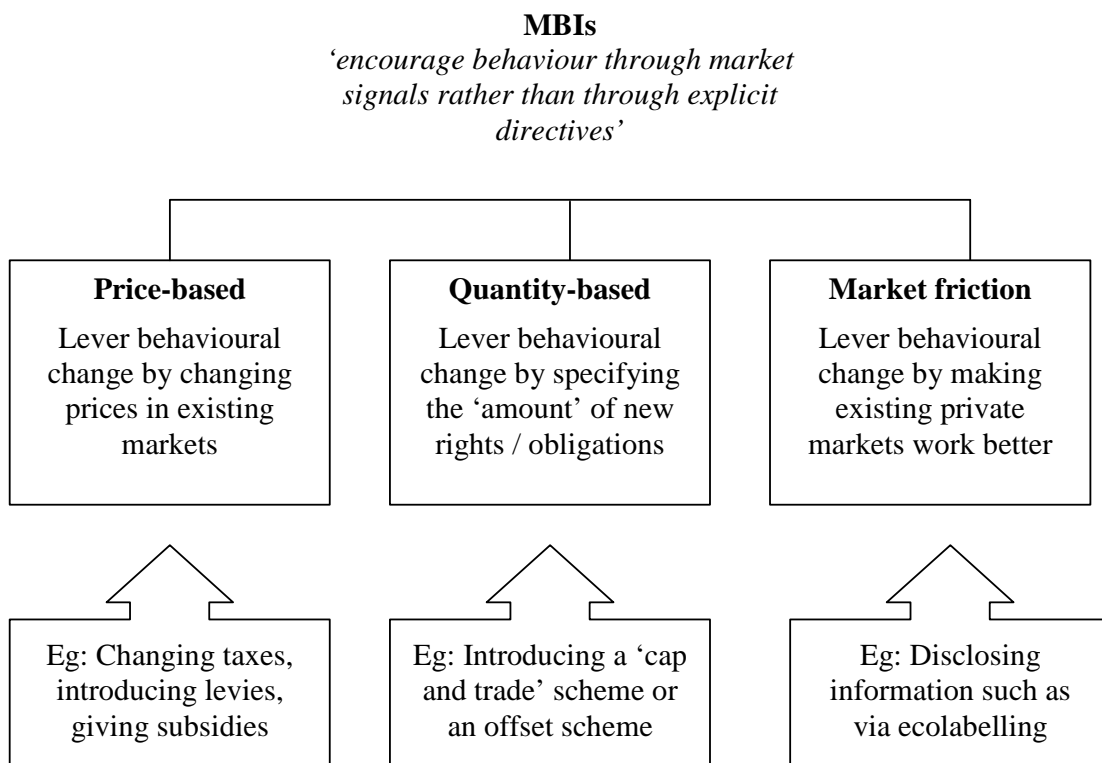
Quantity based or “tradeable rights” instruments create a market in the rights to engage in an activity associated with environmental damage, by restricting the total level of activity and allocating rights to participate in that activity. An efficient allocation of rights is then determined through a market mechanism. Quantity based instruments tend to be used when it is important to get a certain environmental outcome - for example, when pollution of a waterway is close to a level that may cause irreversible or unacceptable degradation.

The environmental regulator must determine the total quantity of the good to be expressed in the rights, as well as a range of parameters that define who can own the various rights, the conditions under which trade can take place, how rights will be monitored and enforced, and so

on. Because of the need to create the regulatory framework necessary for market approaches, their application has predominately been for the management of urban air and water pollution, and for emissions from already regulated and monitored point sources.

“Market friction” instruments try to improve environmental outcomes by making existing private markets work more effectively. They “oil the wheels” of an existing market. Perhaps the most familiar type of market instrument in this category is eco-labelling, which seeks to make existing markets work better by improving the information disclosed in the market.

Figure 1: Types of Market-based Instruments



Market instruments can be used in conjunction with other policy tools, and as indicated above, have often been built on established regulatory platforms. In addition, more than one market instrument can be used to tackle the same environmental issue. For example, participants in the NSW Hunter River Salinity Trading Scheme are also liable for pollution fees, as are licensed sources participating in the NSW nutrient trading schemes on the Hawkesbury-Nepean River. The setting of “soft” non-punitive penalties within tradeable rights schemes also provides a hybrid price and quantity approach, as participants will balance meeting quantity targets with price disincentives posed in penalty regimes. This approach is used in the Renewable Energy Certificates Scheme in Australia.

2.2 Range of trading instruments

With available scientific understanding, and monitoring and enforcement technologies, it is not feasible to establish tradeable rights directly for environmental damages. As a surrogate, rights to a closely related activity can be used to achieve the desired environmental outcome. A successful tradeable rights instrument therefore requires a direct relationship between the activity expressed in the rights and the environmental outcome being sought.

Putting aside this issue for the moment, Table 1 illustrates the range of trading instruments, from simple fee offsets through to more complex trading instruments involving point and diffuse, regulated and unregulated sources of pollution.

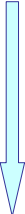


Offset schemes allow regulated sources to achieve pollution abatement requirements through sponsoring abatement effort from other regulated or unregulated (often diffuse) sources. Offset schemes have often been used in conjunction with development consent processes applicable to new operations, and to constrain growth in pollution loads. Over time, modest reductions in total discharges may be realised where offsets are required to be greater than proportional to the requirements imposed on the regulated sources.

Bubble licences involve setting an overall pollution limit over two or a small number of point sources, and allowing them to trade abatement effort. Permit trading schemes involve placing a cap on the overall load of pollutants discharged from a wider set of participating sources, allocating tradeable permits and only allowing discharges commensurate with permit holdings. Diffuse sources may be included in bubble or permit trading directly (by imposing regulatory obligations and requiring them to hold discharge permits) or indirectly through offsets (where diffuse sources can voluntarily enter into arrangements to sell approved abatement effort to point sources).

Bubble and permit trading schemes have often been employed where a significant reduction in pollution loads is required, as they introduce statutory requirements for improvements from all sources (including existing sources) and are not reliant on opportunistic gains associated with new developments.

The simpler trading instruments can often be integrated easily into existing regulatory frameworks. The more complex instruments require more development work and administrative effort to run and these are only likely to be pursued if the anticipated gains from trade are large.

Table 1: Tradeable rights instruments

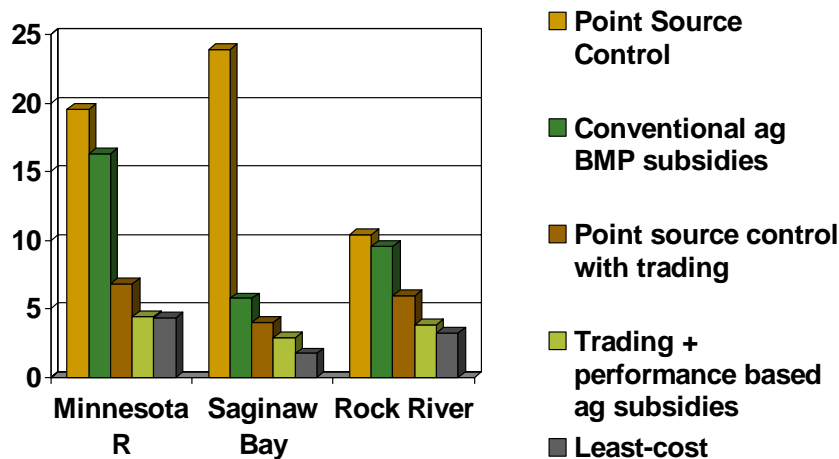
Option	Features	
Fee offsets	Pollution fees paid by regulated (licensed) activities can be reduced through funding off-site nutrient reductions	
Development offsets	Voluntary method for new development to meet development consent conditions through funding off-site improvements	
Licensing offsets	Voluntary method for licensed sources to meet new licence targets – opportunistic, requiring guidelines rather than formal scheme	
Bubble scheme	Small number of point sources meet aggregate nutrient discharge target, statutory based and subject to agreed scheme parameters (e.g. targets, trading rules, monitoring, etc).	increasing complexity, less opportunistic 
Mandatory offset scheme	Rules-based requirement for new developments to arrange appropriate offsets or contribute funds to an offset scheme to ensure rules are met e.g. a “no net increase in pollution” rule. Requirements for existing regulated sources to meet new licence targets could be introduced with a mandatory offset scheme.	
Point source permit trading scheme	Point sources allocated permits that limit discharges but are allowed to trade permits among themselves subject to a set of trading rules	
Point source permit scheme with offsets	As with point source trading scheme, but point sources can use offsets purchased from voluntary (and often diffuse) sources to meet scheme requirements	
Point & diffuse permit trading scheme	Point and diffuse sources allocated permits and all sources can trade to meet requirements	

The choice of instrument depends on many factors. Some of the key factors affecting this choice include the:

- Aims of the scheme
- Extent and significance of different sources of pollution (including point versus diffuse sources, existing versus new, type of discharge – e.g. seasonal, episodic or continuous)
- Differences in abatement costs between sources of pollution
- Environmental context, which may include a number of individual environmental issues
- Level of uncertainty relating to environmental impacts
- Current legislative and policy context
- Level of stakeholder acceptance of regulatory obligations and market based approaches

Studies in the US have examined the potential for tradeable rights instruments to reduce the costs of reducing nutrients in US waterways. The World Resource Institute (Faith 2000) used case studies of three US watersheds to explore the cost-effectiveness and environmental performance of various strategies to reduce phosphorus loads. The study found that policy approaches utilising nutrient trading are dramatically less expensive than conventional point source requirements. Figure 2 below summarises the results.

Figure 2: Cost-effectiveness of US nutrient trading schemes (\$/lb Phosphorus)



Source: Faith (2000)

2.3 Experience with nutrient trading in Australia

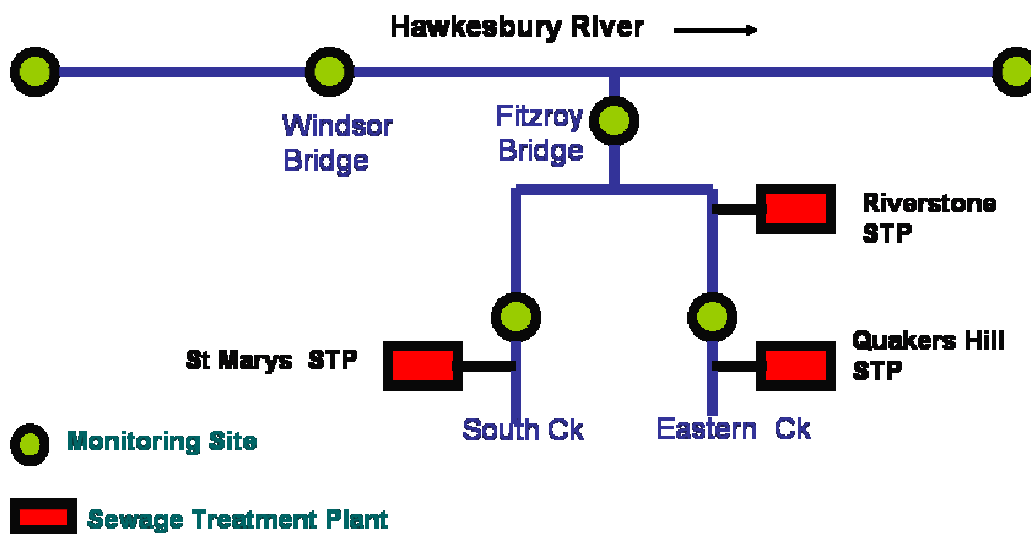
In Australia, emission trading has been used to reduce water pollution through the South Creek nutrient trading scheme in NSW, the Hunter River salinity trading scheme in NSW, and offsets for a wastewater treatment plant at Busselton in Western Australia.

South Creek nutrient trading scheme

Management of nutrient discharges from wastewater plants in the South Creek area of the Hawkesbury-Nepean River provides an instructive example of the use and evolution of trading instruments for water quality management. This has seen the initial introduction of a bubble licensing scheme and subsequent extension to include point and diffuse source trading.

In 1996, the NSW EPA introduced a Bubble scheme which set a limit on total nitrogen and phosphorous loads generated from three wastewater treatment plants (WWTPs) operated by Sydney Water in the South Creek catchment. The scheme limits applied to the aggregate performance of the three WWTPs, rather than specifying limits for each source. The driver for introducing the Bubble was that nutrient concentrations downstream of the South Creek confluence with the Hawkesbury-Nepean River were significantly higher than elsewhere, and had been prone to eutrophication and algal blooms. The location of the WWTPs and ambient monitoring stations are shown in Figure 3.

Figure 3: Location of South Creek Bubble Licensing Scheme



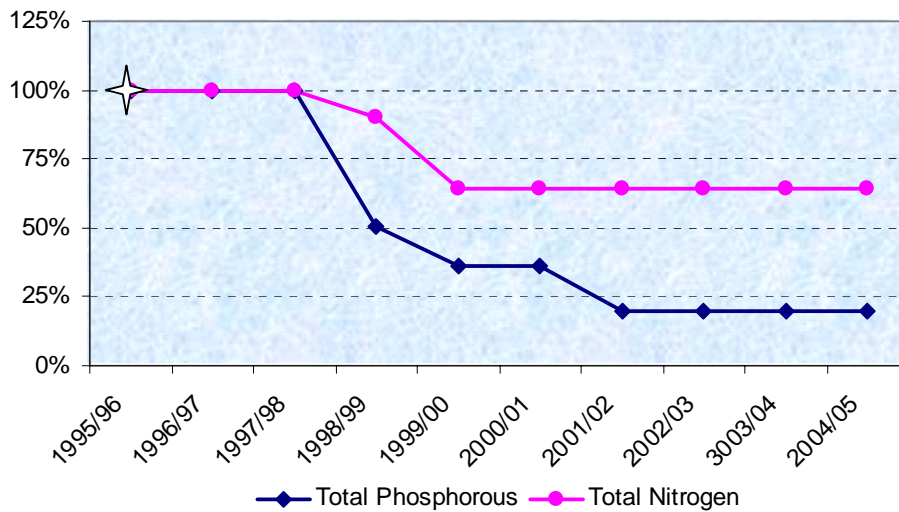
The scheme mandated significant reductions in nutrient discharges from a group of three sewage treatment plants, as shown in Figure 4. In 1995-96, the three plants collectively discharged 11.8 tonnes of Phosphorous and 344 tonnes of Nitrogen. The new load limits required these discharge levels not to be exceeded over the next two years, and then mandated an 83 percent reduction in total Phosphorous and a 50 percent reduction in total Nitrogen over subsequent years.

Since the introduction of the scheme, total discharges have been kept within load limits, while trading has allowed the least cost abatement strategy to be implemented. This strategy saw capital investment for upgrades at the two largest WWTPs – St Marys and Quakers Hill – saving around \$45m compared to a traditional uniform standards regulatory approach. Sydney Water is also saving almost \$1m annually in pollution taxes that would have otherwise been payable under the State's Load Based Licensing scheme had total pollutant loads not been reduced.

Due to increasing population and development predicted in the catchment, further significant capital expenditure will be required to maintain compliance with the Bubble load limits. This has prompted Sydney Water to investigate opportunities for effluent re-use, and in conjunction with the EPA to examine opportunities for diffuse source offsets. This has led to the subsequent introduction of the South Creek nutrient trading scheme.

The South Creek nutrient trading scheme is the first pollution offset scheme to be trialled in NSW. Participation in the two year pilot is voluntary, and will allow premises licensed by the EPA (particularly Sydney Water) and developers to offset nitrogen and phosphorus loads by reducing nutrient pollution at locations outside (but near to) their sites. If the pilot is successful, a more permanent scheme is envisaged.

Figure 4: Reduction in load limits under South Creek Bubble Licence



Currently, the majority of nutrient loads into South Creek are from diffuse sources such as agriculture and urban stormwater. Often reducing pollution from diffuse sources is cheaper than point source reduction on a per unit basis. This is because many diffuse sources can rely on low cost or non-structural measures to reduce pollutants. In addition, regulations have generally focused on point sources for many years and therefore low cost point source controls have already been implemented.

In 2001, the University of Western Sydney identified cost-effective abatement measures for reducing nutrients in the Hawkesbury-Nepean river system, of which South Creek is a tributary. As an example, the cost of reducing phosphorus through run-off detention at a market garden was found to be around \$20 per kilogram per year compared to \$10,000 per kilogram to upgrade current sewage treatment plants.

Sydney Water has agreed to participate in the South Creek pilot and has committed \$100,000 to trial nutrient reduction measures in the catchment. Landcom, a statutory corporation that plans and constructs new residential developments, is also contributing \$50,000 towards the scheme¹.

Under the Pilot scheme these funds will pay for nutrient reduction measures to be put in place in return for a commitment from the landholder to maintain the measures and allow access to their site for monitoring and demonstration of the results. Under a permanent scheme, Councils would be invited to require developers to acquire offsets to achieve a no net emissions goal. Similarly, the EPA will impose the same requirement on new developments and allow existing licencees subject to pollution reduction orders to do so via purchasing offsets.

An initial set of trading ratios have been established to account for the different impacts of pollutants from different sources on water quality, to account for uncertainty around nutrient

¹ See www.epa.nsw.gov.au/greenoffsets/epapilots

reductions associated with the various diffuse source measures and to provide a risk margin for under-performing offsets.

By February 2004 work had started in 2 market gardens on measures to capture run-off containing high levels of nitrogen and phosphorus, which would normally enter South Creek. The run-off will now be collected and reused on the market gardens, instead of entering the creek and contributing to excessive algal growth. A further seven offsets projects have also been contracted. The projects include building wetlands, installing fences to prevent cattle from eroding creek banks and launching a study on how to minimise fertiliser and water use².

2.4 Experiences with nutrient trading in the US

Over the past 20 or so years a range of nutrient trading schemes have been trialled in the United States to help States meet requirements under the Clean Water Act. Under this Act, US states must develop pollutant control strategies, known as Total Maximum Daily Loads (TMDLs), for “impaired” water bodies that do not meet water quality standards. A TMDL determines the daily, seasonal or annual maximum amount of a particular pollutant that a water body may receive and still meet the required pollutant limits for that water body. Once a TMDL is established regulators must introduce measures to reduce pollutant loads. Pollutant trading programs are looked to as the way to minimize the cost of achieving water quality goals in these impaired waters³.

A range of trading structures has been explored, from bilateral trading through to brokers and pollutant banks. To facilitate trade pollution credits must be approved by the regulator, trades must accord with established rules and trade outcomes need to be monitored and enforced. Where trading rules are not established, regulators approve individual trades. The majority of pollution credit buyers to date have been public sector operators of WWTPs as well as a mix of industrial discharges. Increasingly, these point source dischargers are looking to purchase credits from diffuse sources. This has focused considerable attention on whether trades are equivalent in terms the ultimate environmental effect of a tonne of pollution reduced from one source compared to a tonne from another, perhaps distant source.

Important factors for any trade include the physical and chemical characteristics of the water body and the pollutants. Timing of pollutant load to the water body and the seasonality of the discharges must be analysed to insure that short term problems do not result even if overall pollutant loads are reduced. Trading ratios take in to account the attenuation of pollutants between two points in a watershed as well as factoring in a margin to assure that trades will have a net benefit to the water body of concern. Some programs use blanket ratios ranging

² Debus (2004), First sod turned in innovative South Creek Scheme, Minister for the Environment Press Release 27 February

³ Ecosystem Marketplace (2005) *Backgrounder: United States Water Pollutant Trading and Offset*

*from one to one to one to three. Other programs base trading ratios on hydrologic and physical process models for the watershed*⁴.

The Clean Water Act's historical focus has been on point sources. Accordingly key regulations under the Act relates to the National Pollution Discharge Elimination System (NPDES), which monitors and controls point source discharges. Permits issued under the NPDES control discharges through prescribing best available control technologies.

Also under the Act, but independent from the NPDES, are the TMDL requirements for waterway conditions to be assessed and for additional controls to be introduced for impaired waterways. In recent years diffuse sources have emerged as the major source of pollutants and hence regulators have sought to promote improvements from these sources as well as from point sources under the NPDES. However regulatory powers and enforcement provisions relating to diffuse sources have been vague.

Due to the significance of diffuse sources and for political and technical reasons, States have been slow in setting TMDLs for most waterways. But following a series of lawsuits, the USEPA is now pushing States to introduce TMDL targets, including (in aggregate) for diffuse sources.

However TMDLs are only planning tools and do not provide the means for action and enforcement. With the costs of further reductions at point sources increasing, policy makers have looked for ways to effect improvements from diffuse sources, including by expanding nutrient trading to diffuse sources.

In 2003 the US EPA issued nutrient trading guidelines which outlined the conditions under which trading could be administered, in accordance with the Clean Water Act and as part of the NPDES process. In 2004 this was followed with a Water Quality Trading Handbook, which provides advice on developing trading institutions, measuring the equivalency of pollution discharges, establishing rules of trade, assigning liability, and so on. The EPA has also funded a number of reviews of trading experiences, which illustrate the diversity of trading structures being explored.

However as noted by King (2005)⁵, experiences with actual trading have been discouraging – “plenty of guidelines, regional trading institutions, computer simulations of trading and even some well developed water quality trading websites, but very little actual trading taking place”.

By 1999, some 25 trials had been initiated, ballooning to around 70 by 2004 (if schemes currently under development are included). Prominent schemes are shown in Table 2 drawing on the review by Breetz et al (2004)⁶. Despite over 20 years of activity, only a handful of schemes have actually recorded trades and the number of trades in these schemes in turn has been few.

⁴ *ibid*

⁵ King (2005), Crunch time for water quality trading, *Choices* 20(1), pp 71-75

⁶ Breetz, Fisher-Vanden, Garzon, Jacobs, Kroetz and Terry (2004), *Water Quality Trading and Offset Initiatives in the US: A Comprehensive Survey*, Dartmouth College Hanover, New Hampshire.

Key observations from trading experiences to date include;

- Phosphorus has been the most common pollutant targeted and the subject of most trades. Nitrogen discharges have also been a focus, but have largely not been traded. Sediments have been the focus of several schemes, but trades are restricted to the Piasa Creek scheme and indirectly the Rahr Malting Company initiative (where diffuse P, N and sediment reductions were credited for downstream impacts on BOD).
- The majority of schemes and trades have been focussed on freshwater waterways and reservoirs, although more recent initiatives such as Chesapeake Bay are focussed on estuarine and marine water quality.
- Early schemes focussed on trades between point sources, with the focus in more recent years shifting to regulated point sources seeking voluntary diffuse credits from diffuse sources such as cropping and grazing operations, intensive livestock and urban stormwater sources. No initiatives have introduced statutory limits on existing diffuse sources, although limits on new diffuse sources have recently been introduced in the Lake Dillon scheme (although no purchases by such sources have been recorded to date).
- Market structures are increasingly shifting from bilateral trading to the use of offset banks or brokers, particularly for diffuse offset credits. Several markets have established third party Boards that include regulators, community interests and industry representatives. In some instances these Boards review and approve projects. In others, Boards act as a clearing house or exchange by banking and distributing credits. In several instances Governments or broader stakeholder groups have sponsored the creation of demonstration diffuse offset credits, but they have rarely been the subject of subsequent trading.
- Many cooperative efforts at reducing pollution do not closely resemble the "textbook" descriptions of trading. Proponents of trading frequently cite the Tar-Pamlico trading program in North Carolina as a successful example. Instead of individual nitrogen and phosphorus limits for each discharger, the Tar-Pamlico Association shares an overall nutrient discharge cap. The association enforces the cap by allocating nitrogen and phosphorus discharge limits among its members. The association's agreement with the state stipulates that if the collective annual nutrient caps are exceeded, a set fee for every excess kilogram of nutrients will be placed into a fund. That fund then enables farmers to pay for BMPs that reduce nutrients.⁷ Offset payments to a state fund for the development of diffuse source controls are a feature of several schemes, making the instruments more akin to a hypothecated tax.

⁷ Grippo (2003), *Pollutant allowance trading systems offer a new opportunity for improving water quality. How enforceable are they?* Stormwater Vol. 4 (1)

- The most common instances of trading are those where there is only one regulated point source purchasing diffuse offsets to allow an expansion of their activity. Trading is usually bilateral and more akin to “fee for service” rather than a more structured market with price discovery. The key barriers to more widespread trading appear to be;
- Limited demand as regulatory imposts on point sources have been well within the capacity of on-site abatement and/or perceived unwillingness for regulators to enforce limits;
- The greater cost-effectiveness of on-site abatement compared to those forecast; and
- Difficulties negotiating diffuse offsets.

King (2005) argues that the belated implementation of TMDLs may be a necessary market driver to make nutrient trading work, but that further reforms will also be needed. He considers pertinent issues affecting the demand and supply sides of nutrient trading.

On the demand side, King argues that tighter limits on individual dischargers and aggressive enforcement will be needed before any real demand is created. Unlike traditional markets for goods and services, there is no “natural” demand, rather a regulation-driven demand must be created and enforced. Estimates of potential compliance cost savings by regulated sources are less relevant than the *expected cost of not complying*. That is, if the expected cost of not complying is lower than the cost of complying by purchasing credits, there is no economic incentive to trade.

On the supply side, King notes that the willingness of farmers to supply nutrient credits depends on how it may affect their ability to continue receiving agricultural subsidies and green payments, and to fend off future environmental regulations. Offsets are typically calculated as nutrient load reductions over and above what is currently expected of the diffuse source activities – essentially a “Duty of Care”. Farmers are generally not keen for government agents to examine their management practices, establish a Duty of Care benchmark (that may subsequently be used to regulate them) nor to demonstrate that diffuse sources are indeed very low-cost abatement opportunities and hence heighten the likelihood of regulation.

King concludes by stressing that nutrient trading is not an alternative to regulation as often thought by policy makers, but is simply a type of regulation. Weak, vague and largely unenforced discharge restrictions inhibit agricultural diffuse suppliers from engaging in trading just as they inhibit potential point source buyers.

Table 2: Prominent US Water Quality Trading schemes and extent of trading

Scheme	Pollutant	Market Structure	No of trades	Barriers to trade
Bear Creek	P	P-only; bilateral	1	Limited demand (i.e. regulatory limits being met)
Chatfield Reservoir	P	P-P and P-D offsets; bilateral & Gov't NP bank	1	Limited demand (i.e. regulatory limits being met)
Cherry Creek	P	P-P and P-D offsets; bilateral & Gov't D bank	1	Limited demand (i.e. regulatory limits being met)
Lake Dillon	P	P-D offsets and New NP-D offsets; bilateral; P-P <u>not</u> allowed	2	Low cost on-site abatement favoured by point sources
Lower Boise	P	P-D offsets; Bilateral	0	Scheme yet to commence
Kalamazoo River	P	P-D offsets; Bank	0	Limited demand; demonstration ended in 2000.
Minnesota River	P	P-P; Bilateral	0	Scheme yet to commence
Rahr Malting Co.	BOD	P-D offsets; bilateral	4	Trades met full needs of the one point source involved
Minnesota Beet Cooperative	P	P-D offsets; bilateral	several	Trades met full needs of the one point source involved
New York City Watershed	P	P-P, P-D offsets; Bilateral	1	Limited demand and difficulties in negotiating offsets
Neuse River	N	P-P Bilateral, P-D offsets via Bank only	0	Limited demand
Tar-Pamlico	P, N	P-P and P-D offsets: Bank only	0	Lack of formal structure for P-P trade and limited demand for diffuse offsets
Fox-Wolf Basin	P	P-P, P-D offsets; bilateral	0	Limited demand due to soft regulation and low cost on-site abatement
Red Cedar River	P	P-D offsets; bilateral	22	Trades met full needs of the one point source involved
Rock River	P	P-P, P-D offsets: bilateral	0	Limited demand due to soft regulation and low cost on-site abatement
Chesapeake Bay	P, N	P-P, P-D: Bilateral	0	Scheme(s) yet to commence
Piasa Creek	Sediment	P-D offset: Bank	several	Trades likely to meet needs of one P-source involved.

3. NUTRIENT LOADS AND IMPACTS ON MORETON BAY

The Moreton Bay Waterways and Catchment Partnership has undertaken an Ecosystem Health Monitoring Program since 1999 to quantify and evaluate waterway health in SEQ. Within Moreton Bay itself, there are some areas of very poor ecosystem health. Bramble Bay, the southern portion of Deception Bay and the Southern Bay all have significant water quality issues. There is also poor water quality in the Brisbane-Bremer and Logan Albert estuaries and in the Pine and Maroochy estuaries. Figure 5 shows the SEQ catchments and Moreton Bay.

In the freshwater areas, the northern coastal catchments are the healthiest in the region. There are water quality issues in many other catchments with the poorest water quality in freshwaters in the Lockyer, Upper Brisbane, Bremer and Lower Brisbane catchments.

The pollutants of greatest concern in SEQ, including Moreton Bay, have been identified as nutrients and sediments. There has been significant work done to reduce nitrogen from point sources.

3.1 Environmental goals and water quality management

In 2001 the South East Queensland Regional Water Quality Management Strategy (SEQRWQMS) established a goal of 2 ug/L chlorophyll-a for Moreton Bay. The SEQRWQMS set specific water quality objectives for Moreton Bay of 0.22 mg/L of Total Nitrogen and 0.05 mg/L of Total Phosphorus (MBWCP 2001). Nitrogen was identified as the key nutrient limiting algal growth. In order to meet the chlorophyll-a goal, a nitrogen target of 1900 kg/day averaged over a year was established for the Brisbane River discharging to Southern Bramble Bay.

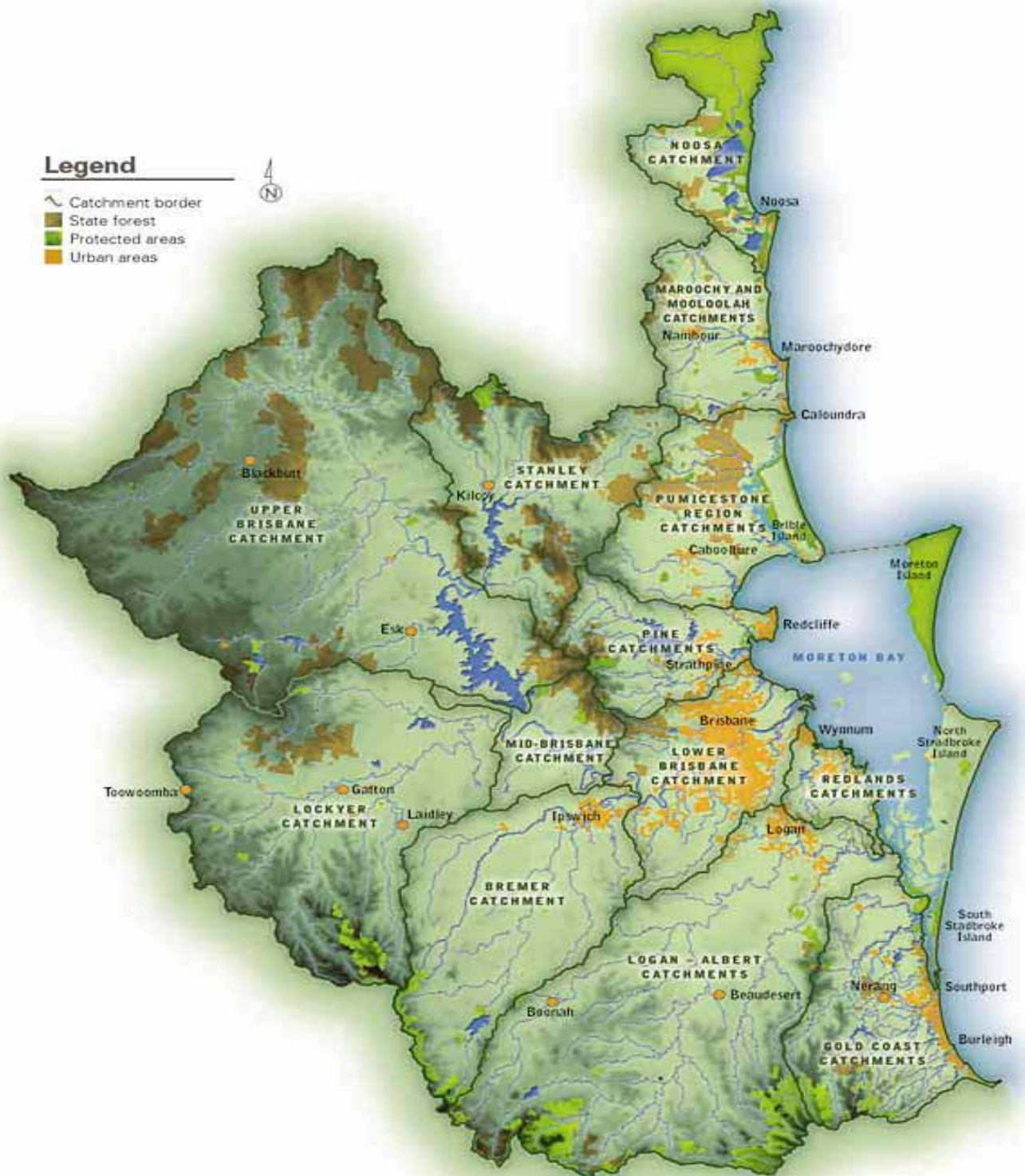
Since then, the EPA has been leading the development of environmental values and water quality objectives for Queensland waters under the Environment Protection Policy 1997. Draft Queensland Water Quality Guidelines have been developed with a range of water quality objectives for different types of estuarine and coastal waterways (EPA October 2004).

The environmental values and water quality objectives will be used for:

- Environmental approvals under the Environment Protection Act 1994
- Government, industry and community planning activities
- Local government planning processes
- Monitoring programs

Total maximum pollutant loads required to achieve the water quality objectives in each SEQ catchment have been developed (WBM Oceanics Australia March 2005).

Figure 5: SEQ catchments ⁸



⁸ Source: Healthy Waterways

The SEQRWQMS sets out 72 management actions agreed in 2001 by *Healthy Waterways*⁹ partners to address declining water quality. A review of the strategy is underway. Key management responses that have been initiated to address water quality include:

- Managing point source pollution – upgrading of 25 sewage treatment plants by the end of 2005 to reduce nitrogen loads has been sought and made an operating requirement under licences held with the EPA
- Stormwater management – preparation of stormwater management plans and installation of new stormwater quality improvement devices as well as maintaining existing devices
- Riparian restoration and maintenance – a range of activities by councils and catchment and community groups such as revegetation, weed and erosion control, fencing and ongoing maintenance
- Waterway and catchment management plans – all major catchments in SEQ are covered by urban stormwater or catchment management plans
- Regulation of vessel sourced sewage – regulations commenced in January 2004 to minimise the impact of sewage discharged from vessels.
- State and local government planning provisions and regulatory controls – provisions relate to protection of waterways and protected areas, requirements for water sensitive design for new development, sediment and erosion control on building sites, and vegetation management legislation.

A number of codes of practice are also available to assist in managing the environmental impacts of agricultural activities. These include:

- Environmental Code of Practice for Agriculture
- Environmental Code of Practice for Australian Prawn Farmers
- Code of Practice for Queensland Piggeries
- Code of Practice for Sustainable cane growing in Queensland
- Farmcare - Code of Practice for Sustainable fruit and vegetable production in Queensland
- Queensland Dairy Farmers Environmental Code of Practice

It is proposed that stormwater plans be included in the Total Management Planning (TMP) process (run by the Department of Natural Resources and Mines and Department of Local Government and Planning). TMP integrates corporate planning, asset management, client

⁹ Healthy Waterways is a program of the Moreton Bay Waterways and Catchments Partnership (the Partnership), a whole-of government, whole-of-community collaboration. The Partnership resulted from the combination of the Brisbane River Management Group (1991 – 2001) and the South East Queensland Regional Water Quality Management Strategy project (1995 – 2001) and seeks to build on the outcomes of these programs

service, and environmental management programs into one system. TMPs are drawn up by councils and used to assess eligibility for state subsidies namely the Local Governing Bodies' Capital Works Subsidy Scheme - this scheme provides State Government subsidies to Local Government for approved capital works on water and waste sewerage infrastructure to 40 percent and on sewerage effluent reuse infrastructure to 50 percent. The Scheme has underpinned the waste water treatment plant upgrades and reuse in SEQ to date. From 2008 stormwater management measures may be eligible for a subsidy.

3.2 Current and future nutrient and sediment loads and sources

There is a range of point and diffuse sources contributing to nutrient and sediment loads in SEQ. Current sources, their levels of nutrient and sediment loads, and projected increases in loads under a "business-as-usual" scenario are canvassed in this section.

3.2.1 Nutrient loads

Table 3 shows the proportion of annual nutrient loads from point and diffuse sources currently in SEQ.

Table 3: Current annual nutrient loads from point and diffuse sources in SEQ (tonnes per year)

	Nitrogen	%	Phosphorus	%
Point sources ¹	2,045	38%	1,094	69%
Diffuse sources ²	3,362	62%	487	32%
Total	5,407		1,581	

1 Includes only dry weather loads from point sources.

2 Excludes land use category "woody", includes estimated loads from on-site wastewater systems in coastal areas.

Sources: Diffuse source data from EMSS used for *Estimation and Allocation of Total Maximum Pollutant Loads to achieve Water Quality Objectives in SEQ Waterways Stage 10b report*, WBM Oceanics Australia March 2005

Data for on-site wastewater systems from *Audit of Non-Sewered areas in SEQ, prepared for Moreton Bay Waterways and Catchments Partnership*, December 2003

Point source data held by EPA at June 2005

It should be noted that the numbers presented in Table 3 are annual loads and the importance of different sources of nutrients will vary under dry, average and wet conditions. The point source loads presented here are statistic based data: average dry weather flow multiplied by median concentration. They do not include wet weather effects and therefore may underestimate total point source loads.

The annual loads suggest that diffuse sources dominate current loads of total nitrogen, whereas point sources dominate phosphorus loads. Recent upgrades of sewage treatment

plants have focused on reducing nitrogen loads and as a result diffuse sources now contribute over 60 percent of nitrogen loads. Once upgrades in progress are also complete diffuse sources will contribute around 74 percent of nitrogen loads. It should be noted that the impacts of point and diffuse sources of nutrients can be quite different. This is explored further in section 3.3.

There are around 60 point sources that are licenced by the EPA to discharge nutrients in SEQ. There are around 45 sewage treatment plants, 10 prawn farms and other industrial activities such as oil refineries, paper mills, meat works and fertiliser works. There are also a number of other potential sources of nutrient discharges which are not licensed by the EPA. These sources are not permitted to discharge nutrient loads to waters. They include around 30 feedlots, 15 abattoirs and 7 piggeries.

The diffuse sources include stormwater runoff from commercial and residential areas, overflows from wastewater treatment plants, on-site wastewater treatment systems as well as runoff from agriculture. There is a diverse range of agricultural land uses including beef and dairy cattle grazing, sugarcane and pineapple plantations, poultry farming, plant nurseries, cereals, vegetable and flower farms, and hobby farms. In 2003 it was estimated that there were around 120,000 on-site wastewater treatment systems in SEQ.

Figures 6 and 7 show the overall contribution of different activities to annual nutrient loads.

Figure 6: Current contribution of sources to annual nitrogen loads (2003-04)

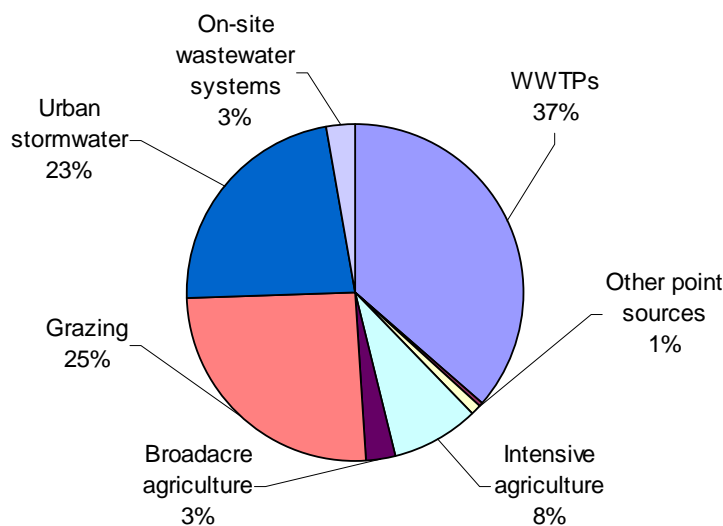
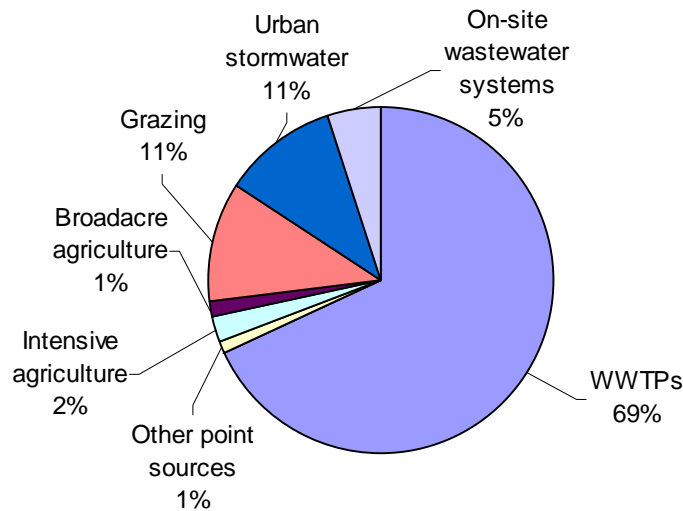


Figure 7: Current contribution of sources to annual phosphorus loads (2003-04)

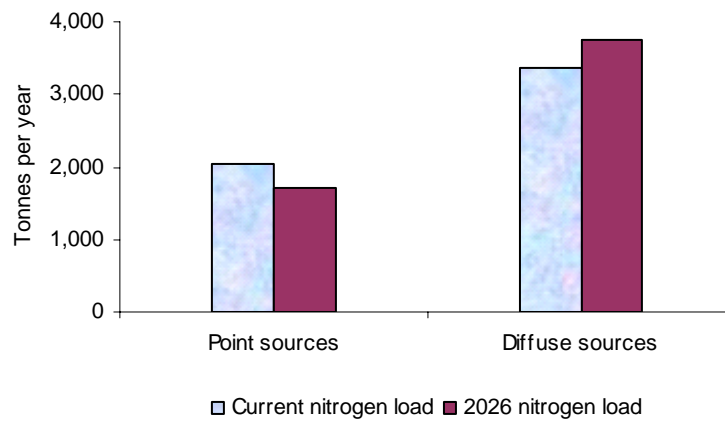


Care is needed when comparing the load contributions of different sources as they have different impacts due to the pollutant composition, location, timing of the discharge and the environmental conditions of receiving waters. These issues are explored further in section 3.4 on environmental equivalence. The only source where there is no data available is for sewerage overflows. Overflows are an intermittent source resulting either from extreme wet weather or failure of equipment.

Grazing activities, urban stormwater and sewage treatment plants are all significant contributors to annual nitrogen loads (each contributing over 20 percent). Intensive agriculture also contributes around 8 percent. WWTPs dominate annual phosphorus loads, contributing around 69 percent of the total annual load. Grazing activities and urban areas also make a significant contribution (contributing over 10 percent each).

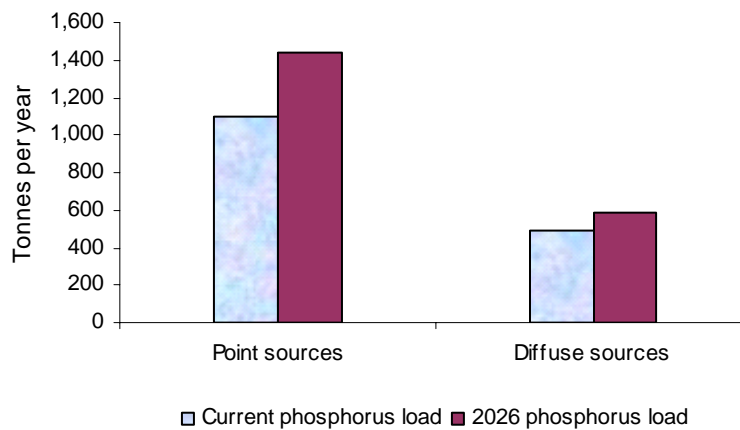
The population of SEQ is expected to increase by 1 million by the year 2026. As a result, pollution loads from both point and diffuse sources are expected to increase without management measures to reduce loads. Figures 8 and 9 show the projected growth in nutrient loads by 2026 under a business as usual scenario. The projected loads under the business as usual scenario incorporate increases in loads in line with the expected impact of population growth and reductions in loads where major upgrades of wastewater treatment plants are already underway.

Figure 8: Projected growth in nitrogen loads by 2026



Source: Data sources are the same as for Table 3.

Figure 9: Projected growth in phosphorus loads by 2026



The point source loads of nitrogen are expected to decrease by 16 percent even in the face of increasing population growth as a result of current upgrades underway at WWTPs. Phosphorus loads are expected to increase by 32 percent as increasing population increases the volume of wastewater processed by WWTPs (even though there will be some reduction of phosphorus loads associated with the upgrades targeting nitrogen). Diffuse loads are also expected to increase as a result of new development. In 2003, the number of on-site wastewater systems was expected to increase by 47 percent over ten years. Overall nitrogen loads from diffuse sources are expected to increase by 12 percent and phosphorus loads by 20 percent (see notes to Table 3 for information sources). Again it should be noted that nutrients from point and diffuse sources of nutrients can be quite different. The reasons for the differences are explored further in section 3.3.

3.2.2 Sediment loads

Table 4 shows the proportion of annual sediment loads from point and diffuse sources currently in SEQ. Almost all sediment loads in SEQ are from diffuse sources.

Table 4: Current annual sediment loads from point and diffuse sources in SEQ (tonnes per year)

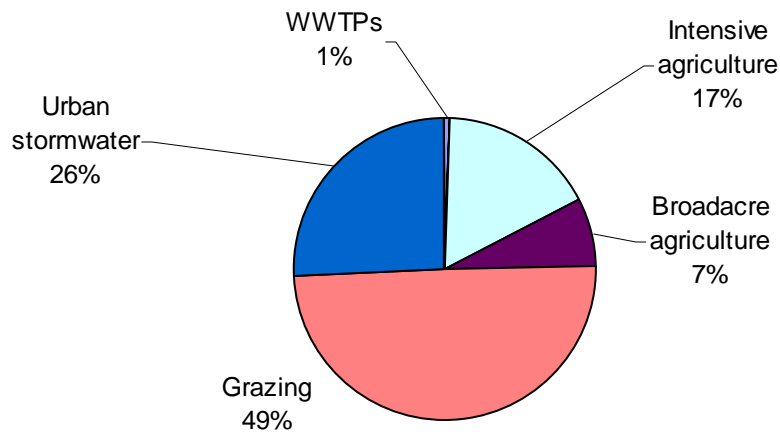
	Sediment Loads	%
Point sources	1,729	1%
Diffuse sources*	266,530	99%
<i>Total</i>	268,259	

* excludes undisturbed native vegetation

See notes to Table 3 for sources of information

Figure 10 shows the overall contribution of different activities to annual sediment loads.

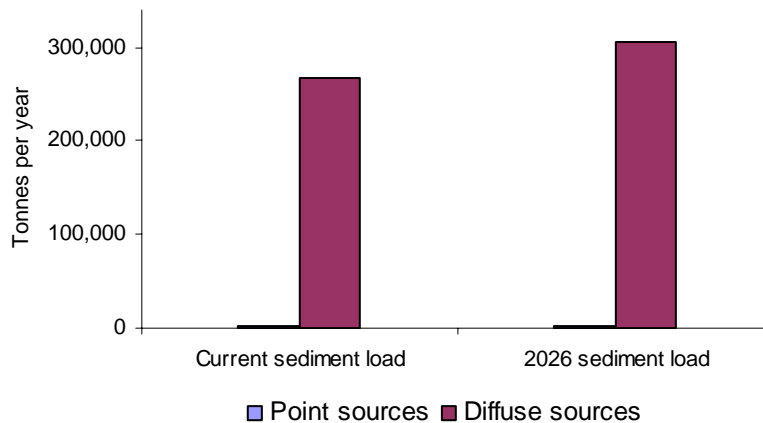
Figure 10: Current contribution of sources to annual sediment loads



Grazing areas contribute to around half of all sediment loads. The other major contributors are urban stormwater and intensive agriculture.

Figure 11 shows the projected growth in sediment loads by 2026 under a business as usual scenario.

Figure 11: Projected growth in sediment loads by 2026



With the increase in population point source sediment loads are expected to increase by 39 percent by 2026. Diffuse loads are also expected to increase (by around 17 percent).

3.3 Environmental equivalence

In the preceding discussion, no distinction has been made between nutrient and sediment loads from different sources in terms of how they may ultimately impact water quality goals discussed in Section 3.1. To the extent that differences exist, they must be accounted for in instrument design as trading requires a metric that defines the good being traded. For some environmental goods such as many air pollutants, tonnes discharged offer a reasonably robust metric. However in some instances the environmental goods are less homogeneous, such as is often the case for water pollutants and biodiversity. In these instances, establishing the “environmental equivalence” of goods to be traded in the market is essential.

The term environmental equivalence refers to the difference between the impacts of pollution from different sources on an environment issue. The environmental equivalence is often stated as a ratio – for example an environmental equivalence ratio of 1:3 for two sources means that 1 tonne of pollutant from the first source is expected to have a similar impact on environmental amenities to 3 tonnes from the second source.

The issue of environmental equivalence is important to consider for this project because it is only possible to facilitate trading to minimise the costs of reaching policy goals where environmental equivalence between different pollution sources can be established. However, it is also important for policy making in Moreton Bay more generally as it can assist in directing greater effort to sources where environmental payoffs will be higher.

The reason for the difference in impacts between two sources may be due to:

- Their location
- The types of discharges
- The timing of the discharges

- Hotspot or spillover impacts

In the Moreton Bay context there are also a number of different environments being impacted: the freshwater areas, estuaries and the bay. The environmental equivalence may be different depending on which impact is the focus.

Trading ratios adopted in several point-diffuse trading schemes in the US are shown in Table 5, drawing on the work of Breetz et al (2004)¹⁰.

The EPA has provided preliminary background information on potential environmental equivalence for major catchments in SEQ. The information primarily focuses on impacts on the estuaries and bay. The discussion below draws from the EPA information provided and subsequent discussions with officers of the EPA and Healthy Waterways.

As an example of differences due to *location*, a WWTP discharge in a lower estuary of one of the Moreton Bay catchments is likely to have a greater impact on the Bay than an WWTP discharging in the upper estuary.

Considering differences in the *type of discharge*, the impacts of nutrient discharges from two WWTPs in Moreton Bay would be very similar, however the impact of discharges from aquaculture or diffuse sources are likely to be different (with more particulate bound nutrients). There are also differences in the nature of sediment between point and diffuse sources – with WWTP sediments largely biologically based and diffuse source sediment geologically based. Also, highly dispersive soils such as the Marburg soils in the upper Logan catchment, appear to have a greater tendency to travel and cause environmental impacts.

The *timing of the discharge* is also very relevant in the Moreton Bay context. For example, WWTP loads are relatively constant, while loads from prawn farms are seasonal (with loads gradually increasing from September and peaking over summer/autumn), and loads in runoff from agriculture occur in wet weather. Each of these factors influences the environmental equivalence between the sources. It is likely that the environment will cope better with 10 tonnes of nutrients delivered in spikes compared with 10 tonnes of nutrients delivered in a constant flow.

¹⁰ as described in Breetz, Fisher-Vanden, Garzon, Jacobs, Kroetz and Terry (2004), Water Quality Trading and Offset Initiatives in the US: A Comprehensive Survey, Dartmouth College Hanover, New Hampshire

Table 5: Trading ratios adopted for point-diffuse trading in US schemes

Scheme	Pollutan	Trading ratios
Chatfield Reservoir	P	The generally accepted trading ratio for both point and diffuse sources is 2:1. However, all trades must be approved by the Water Quality Control Commission on a case-by-case basis, so ratios may differ across trades.
Cherry Creek	P	The minimum ratio used in calculating credits exchanged in new trade projects is 2:1, diffuse : point source discharges. The trade ratio can be adjusted up to a value of 3 on a project-specific basis, such as when the point source discharge is further away from the reservoir than the diffuse source project location.
Lake Dillon	P	A 2:1 trading ratio between point and diffuse sources and a 1:1 trading ratio between diffuse sources is applied
Lower Boise River	P	Trading ratios have been established that reflect river location, site location, and drainage delivery. Diffuse source load credits are multiplied by three ratios to determine the number of tradable credits: <ul style="list-style-type: none"> (1) “river location ratio” that reflects how phosphorus reductions throughout the watershed will have differential impacts on the water quality: (2) “drainage delivery ratio” to account for transmission losses within a drainage channel; and (3) “site location factor” to account for transmission losses between cropland and drainage channels.
Kalamazoo River	P	Trading ratios were used both to deal with uncertainty and to guarantee a net environmental benefit with each trade. The trading ratio for point-diffuse trades was 2:1 based on adoption of BMPs, and 4:1 was used for credits from “generally accepted” agricultural management practices. Any point-point trades would have a 1.1:1 trading ratio. However trading ratios could also be varied on a case-by-case basis to address equivalence issues arising due to distance, seasonality, and form.
Minnesota Beet Cooperative	P	The trading ratio for point – diffuse (agricultural BMPs) trades is 2.6:1, which reflects 1 kg for the offset, 1 kg for environmental improvement, and 0.6 kg as an “engineering safety factor”.
New York City Watershed	P	The trading ratio for point – diffuse (including agricultural BMPs, stormwater retrofits, and land reclamation and wetland restoration) trades is 3:1.
Tar-Pamlico Basin	P, N	The effective trading ratio is 2.1:1, and includes riparian buffers, fertilizer application, stormwater, and agricultural diffuse sources. This reflects a margin of safety of two plus 10 percent administrative costs
Red Cedar River	P	The trading ratio for point – diffuse is 2:1, with diffuse offsets via farmers adopting no till or reduced intensity of tillage on lands that test high for phosphorus content

The EPA has indicated that environmental equivalence ratios can be established for point sources in the estuaries in Moreton Bay. Most of the WWTPs are located in the estuaries and this has been the largest focus of monitoring over the past five years. The EPA has also provided a list of locations with the greatest potential for an environmental equivalence of 1:1 between point sources (given other equivalency tests are also passed). These locations are:

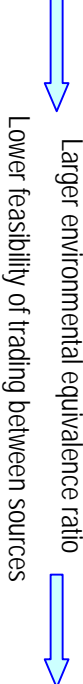
- Lower Maroochydore River Estuary
- The Bramble Bay Cluster - Pine River estuary, Cabbage Tree Creek estuary and Lower Brisbane estuary
- Mid Brisbane River Cluster - Mid Brisbane estuary and Oxley Creek estuary
- Upper Brisbane River Cluster - Upper Brisbane and Bremer River
- Lower Logan Estuary Cluster - includes Lower Logan estuary & part of Southern Moreton Bay
- Logan/Albert Estuary Cluster - includes the Upper Logan estuary and Albert estuary

The EPA has indicated that environmental issues in freshwater areas are much more complicated and there is much less information available on the nature of diffuse source pollution. The EPA's preliminary advice on environmental equivalence between point sources in estuaries and diffuse sources in freshwaters is that it is likely to be 1: very high (e.g. 1:100) in many instances.

Given the complexity in establishing equivalence ratios between point and diffuse sources, it is worth considering instances where discharges from the two are more similar. For example, comparing a wet weather discharge from a WWTP with runoff from an agricultural activity would be easier because there is no timing issue to address. Similarly, comparing a runoff from an agricultural activity in the same part of the estuary where the WWTP discharges would also be simpler because there is no need to deal with the difference in location.

There are a range of different pollution source combinations that have significantly different environmental equivalence ratios. Some of these are shown in Table 6 in order of the most similar discharges.

Table 6: Pollution source combinations

Equivalence Category	Types & locations of discharges	
Point - point	Point source discharges within the lower parts of estuaries, clusters of lower estuaries or clusters of lower estuaries and bays Point source discharges in lower estuaries and upper estuaries in the same catchment	 Lower feasibility of trading between sources Larger environmental equivalence ratio
Point - diffuse	Point source wet weather discharges and diffuse source discharges within estuaries Point source dry weather discharges and diffuse source discharges within estuaries Point source wet weather discharges in estuaries and diffuse discharges in freshwaters in the same catchment Point source dry weather discharges in estuaries and diffuse source discharges in freshwaters	

The environmental equivalence issues have implications for choosing the pilot catchment/cluster as well as the type of trading instrument.

The difficulties in establishing equivalence between point and diffuse sources suggests that any trading mechanism involving diffuse sources should allow for assessment of equivalence on a case-by-case basis (rather than attempting to set up a rules based system).

A final issue is the potential for pollutant trading to create **hotspot or spillover impacts**. If a trading scheme focused on improving water quality benefits in Moreton Bay, and included trading ratios premised only on these relative impacts, then unintended impacts in catchments and estuaries may arise. For example, pollutant trading that resulted in nutrient reduction credits being traded to facilitate expanded upper catchment activities may lead to “hotspots” where freshwater water quality deteriorated. Alternatively, trading in the opposite direction is likely to lead to spillover environmental gains in upper catchment water quality.

3.4 Excluding sediments from the pilot program

Typically, sediment discharges to waterways result from diffuse source activities such as stormwater in the urban context and grazing and agricultural activities, as well as streambank erosion in the rural context.

A review of each SEQ catchment, provided in Appendix 1, indicates that in the SEQ catchments over 99 percent of total annual sediment loads are from diffuse sources.

Accordingly, a sediment trading program would therefore require the introduction of statutory discharge limits on diffuse sources, to create the demand for trading. Two trading instruments could be used – either the introduction of development offsets or a sediment trading scheme.

A sediment development offsets scheme would require designated developments to acquire offsets for some or all of their sediment discharges from voluntary offset providers (also diffuse sources). However as shown in section 3.2.2, future loads are considerably less significant than current sediment loads, and so reliance on development offsets, even with offset ratios greater than 1:1 will make only a modest contribution to overcoming the problem.

A sediment trading scheme in principle offers a more strategic means to reduce overall sediment loads, including reducing loads from new developments and ensuring reduced loads from current sources. However such a scheme would require statutory sediment discharge limits to be placed on the diffuse urban and rural sources. In the SEQ context this would:

- Present significant risks as there is no international experience to draw on;
- Mean much greater difficulty in establishing robust equivalence ratios, due to uncertainties in estimating sediment generation rates from different sources and management practices, spatial and temporal differences between diffuse sources, as well as transport issues;
- Impose significant costs on regulators and the diffuse sources in identifying current loads, allocating load liabilities, and in monitoring and enforcing compliance.

A fourth issue relates to the “cost-sharing” implicit in introducing statutory nutrient discharge limits on diffuse sources, particularly rural based activities. While point source activities such as WWTPs, industrial plants and urban development have a long history of regulation and acceptance of a “polluter-pays” ideology, environmental gains in the rural sector have often been fostered via “beneficiary-pays” policies, such as subsidies for fencing and buffer strips or for the adoption of alternative management practices. Following experiences in the US, it may be more tenable in the pilot to include diffuse sources through voluntary (beneficiary-pays) offset mechanisms rather than expose the pilot to broader cost-sharing debates.

These issues pose significant risks that may delay implementation of a pilot program, impose excessive costs on the Government and participants and undermine the effectiveness of trading to deliver real reductions in overall sediment loads and improved water quality. For these reasons, we recommend that sediments not be a focus of the initial pilot trading program.

The rest of this scoping report focuses on opportunities for nutrient trading for Moreton Bay. However, it should be noted that if a subsequent pilot nutrient trading program includes rural and stormwater sources, such as through voluntary offsets, this is likely to have a positive impact on sediment loads as many actions to reduce nutrients will also reduce sediments. If

this “spillover” impact were thought significant, it could be explicitly recognised in trading arrangements so that overall water quality benefits are accounted for and maximised.

Queensland government agencies are researching market or incentive based possibilities relating to sediments and there may be opportunities to draw on this experience for Moreton Bay in the future. For example the following programs are being developed as part of the reef water quality protection plan:

- Programs to establish conservation agreements and covenants to protect and manage remnant and riparian vegetation and wetlands; and
- A pilot auction program that targets the conservation of wetland, riparian and other remnant vegetation that has a direct relationship with water quality improvements in high risk reef catchments.

While alternative policy options for managing diffuse sources are outside the scope of this study, there are some other policies that would be likely to provide benefits for any subsequent development of a trading scheme including diffuse sources. These include:

- Research to target pollution abatement efforts
- Demonstration sites
- Collecting information on the costs and effectiveness of various management techniques for reducing diffuse pollution
- Collecting information on the environmental equivalence of diffuse sources

4. IDENTIFYING A PILOT REGION

The fourteen SEQ catchments have been reviewed in order to select a short list that would be most suitable as a pilot catchment for nutrient trading. For each catchment the review examined:

- | | |
|----------------------|--|
| <i>Environmental</i> | <ul style="list-style-type: none"> • Extent to which pollutant reductions from the catchment would deliver environmental gains (load reduction or additional load avoided) for Moreton Bay • Extent to which scientific knowledge exists with which to establish robust equivalence ratios for major pollutant sources |
| <i>Economic</i> | <ul style="list-style-type: none"> • Extent to which there is diversity in classes of pollutant sources within the catchment • Extent to which diversity also between new/existing sources; point/diffuse; regulated/unregulated |
| <i>Stakeholder</i> | <ul style="list-style-type: none"> • Ability and willingness of stakeholders to participate in a trading instrument |
| <i>Regulatory</i> | <ul style="list-style-type: none"> • Adequacy of regulatory framework and operations in catchments to support a trading instrument |
| <i>Strategic</i> | <ul style="list-style-type: none"> • Presence of problematic or priority sources in the catchment (e.g. aquaculture, urban growth, diffuse agriculture) |

The reviews of each SEQ catchment are provided in Attachment 1 along with a summary table providing the key reasons for short listing or culling of catchments.

This section provides an overview of the five catchments that were assessed as high feasibility catchments for a pilot trading instrument, considers potential clusters of catchments and makes a recommendation as to the most suitable pilot area.

4.1 Overview of high feasibility catchments

The five high feasibility catchments identified for further consideration are:

- Lower Brisbane River
- Pine Rivers
- Logan/Albert Rivers
- Caboolture River
- Bremer River

Table 7 shows the reduction in current nutrient loads required to meet water quality objectives in the draft 2004 Queensland Water Quality Guidelines. In all catchments, very large reductions from current loads will be required. This will be made particularly challenging due to an anticipated increase in nutrient loads associated with ongoing development in SEQ.

Table 7: Reduction in current Phosphorus and Nitrogen loads required by catchment (% reduction from current loads)

Catchment	Total N	Total P
Logan/Albert	91%	97%
Lower Brisbane	84%	97%
Bremer	94%	97%
Caboolture	75%	88%
Pine	85%	95%

Source: *Estimation and Allocation of Total Maximum Pollutant Loads to achieve Water Quality Objectives in SEQ Waterways Stage 10b report*, WBM Oceanics Australia March 2005

Table 8 shows the increases in total pollutant loads expected by 2026 in each catchment under a “business-as-usual” scenario. Load increases are primarily driven by population growth, with the population of SEQ forecast to increase by 1 million by 2026. In addition, potential growth in industries such as aquaculture will place further pressure on nutrient loadings in Moreton Bay.

Table 8: Change in catchment nutrient loads by 2026 under a BAU scenario

Catchment	N	P
Logan/Albert	14%	25%
Lower Brisbane	-20%	25%
Bremer	17%	37%
Caboolture	13%	24%
Pine Rivers	-13%	16%

Source: EMSS data in WBM Oceanics 2005

All of the high feasibility catchments have significant expected increases in phosphorus loads. The Bremer catchment has the greatest expected percentage increase in phosphorus loads between now and 2026. The lower Brisbane and Pine Rivers catchments are likely to decrease overall nitrogen loads over this timeframe due to current upgrades underway. However, the present round of upgrades will not be enough to ensure that WWTPs in these catchments stay within their load limits in the face of increasing population and inflows.

In all high feasibility catchments both point sources and diffuse sources contribute to nitrogen and phosphorus loads. Table 9 shows the contribution of regulated point sources to nitrogen and phosphorus loads for the high feasibility catchments, while the classes of point and diffuse sources by pollutant by catchment is shown in Figure 12.

Table 9: Current contribution of regulated point sources to total catchment nitrogen and phosphorus loads

Catchment	N	P
Logan/Albert	16%	54%
Lower Brisbane	68%	88%
Bremer	10%	43%
Caboolture	19%	35%
Pine	54%	75%

The Logan/Albert, Bremer and Caboolture catchments have the greatest contributions from diffuse sources. In particular, the Marburg soils in the upper Logan catchment are easily eroded and have a greater tendency to travel and cause environmental impacts.

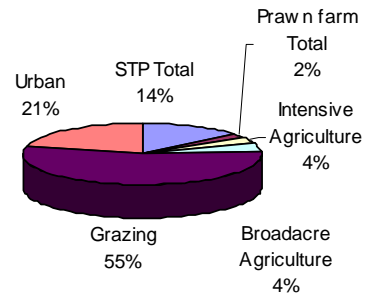
In the Lower Brisbane and Pine catchments, point sources dominate phosphorus loadings and contribute a significant proportion of nitrogen loadings. Even after current upgrades at WWTPs are complete, point sources will still contribute 50 percent of total nitrogen loads in the Lower Brisbane (and 40 percent in the Pine). In the other catchments, phosphorus loadings are significant while nitrogen loadings are modest at 10 – 19 percent of total loadings.

As shown in Figure 12, waste water treatment plants (WWTPs) dominate point source loadings, while diffuse sources variously include urban (principally stormwater), grazing and agriculture. Each class of diffuse source loadings typically comprise a large number of individual farms or drains contributing to the total loading. However in the case of regulated point sources, often a small number of premises contribute most of the estimated nutrient loads.

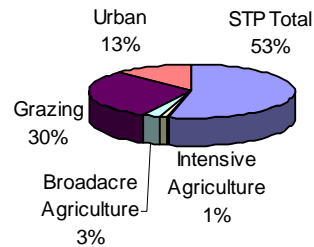
Figure 12: Pollutant sources by catchment

Logan/Albert catchment

Nitrogen load budget (kg/yr)

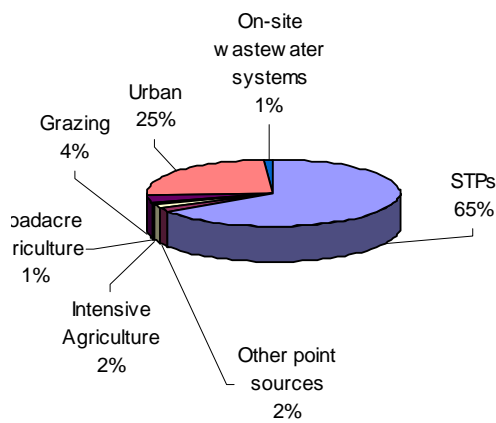


Phosphorus load budget (kg/yr)

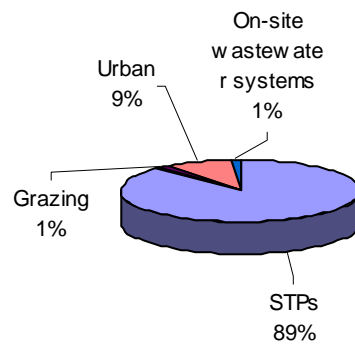


Lower Brisbane

Nitrogen load budget

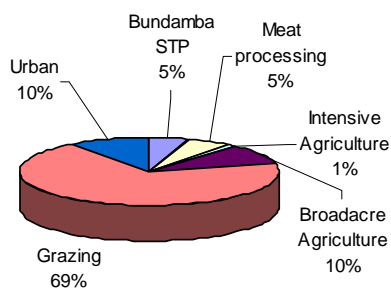


Phosphorus load budget

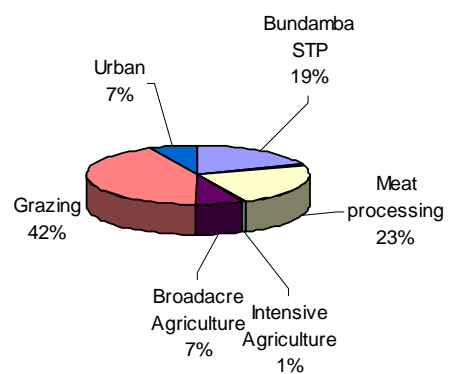


Bremer

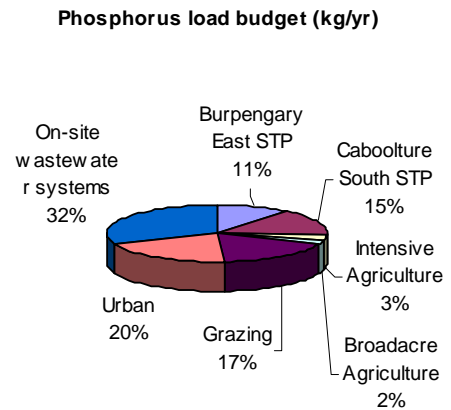
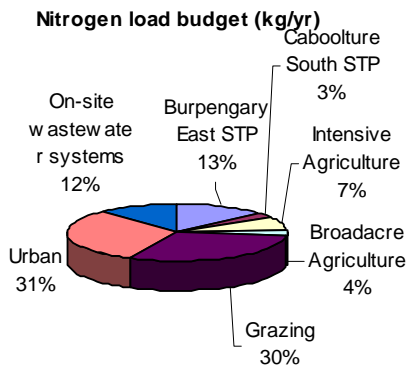
Nitrogen load budget (kg/yr)



Phosphorus load budget (kg/yr)



Caboolture



Pine

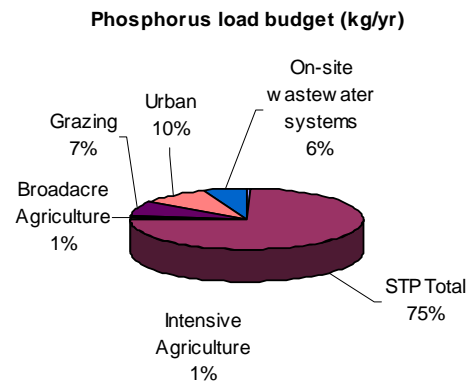
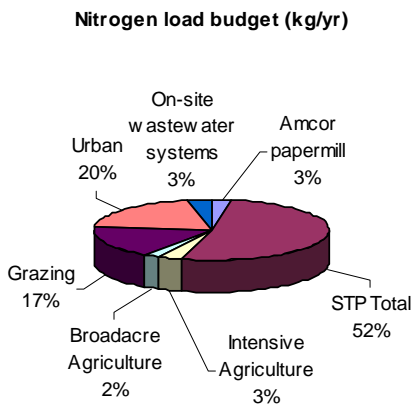


Table 10 shows the estimated number of regulated point sources (with significant discharges) in each of the five catchments. Notably, the Logan/Albert catchment has the greatest number of point sources, yet as shown in Table 8, they are only a modest contributor to nitrogen loadings. It should also be noted that within the Logan/Albert the Loganholme WWTP is estimated to contribute around 60 percent of the nitrogen loads and 90 percent of phosphorus loads from point sources. In the lower Brisbane catchment the loads are more evenly spread across point sources (with the Luggage Point WWTP contributing 53 percent of nitrogen and 45 percent of phosphorus loads).

While point sources in the Pine catchment which were estimated to contribute some 50 percent of total nitrogen loadings, this is from only five WWTPs.

Table 10: Number of regulated point sources by catchment*

Catchment	WWTPs	Other	Total
Logan/Albert	5	9	14
Lower Brisbane	9	3	12
Bremer	2	1	3
Caboolture	2	0	2
Pine	5	1	6

* includes only point sources discharging nutrients

Ideally the pilot catchment selected would have opportunities for trading among point sources, as well as trading between point and diffuse sources. There is limited scope for point source trading in the Bremer, Caboolture and Pine catchments due to the small number of point sources. In the Logan/Albert, point source trading may also be restricted. While there are some 14 point sources, one WWTP dominates the total point source load of nutrients, and in the case of nitrogen, the total point source load is only some 16 percent.

The Lower Brisbane catchment has 12 point sources, and while the Luggage Point WWTP dominates, it represents only around half of total point source loads. Total point source nutrient loads are substantial and there is therefore likely to be good opportunity for point source trading. The significant spatial separation of the point sources will raise environmental equivalence issues which may serve to moderate potential trade benefits. However, the smaller contribution from diffuse sources in this catchment (only 13 percent in the case of phosphorus loads) is the major limitation as it offers fewer opportunities for trading involving diffuse sources.

As none of the high feasibility catchments proved attractive for the full suite of market structures, the focus shifted to reviewing the “clusters” of catchments which were introduced in Section 3.3 in relation to environmental equivalence – as this provides a basis to identify cross-catchment areas whilst minimising the difficulties of establishing the equivalence of loads from distant sources.

4.2 Review of potential trading “clusters”

As part of the earlier discussion on environmental equivalence a number of clusters were identified where there is greater potential for 1:1 environmental equivalence between sources. These clusters are based around estuaries and cut across catchment boundaries. Table 11 shows the number of point sources in each cluster (that includes parts of high feasibility catchments) and comments on the extent to which particular sources dominate pollution loads.

Table 11: Point sources in clusters

Cluster	Number of WWTPs	Number of other point sources	Largest contributor of point source nutrient loads
Bramble Bay	7	2 oil refineries 1 fertiliser works 1 paper mill	Luggage point WWTP 43% of N and 62% of P
Lower Logan	0	9 prawn farms	
Upper Logan	2	0	Loganholme WWTP 76% N and 94% P
Upper Brisbane/Bremer	4	1 meat works	Meat works 32% N Goodna WWTP 16% P
Mid-Brisbane	2	0	Oxley WWTP 96% N and 95% P

The greatest number of point sources (11) is in the Bramble Bay cluster, although one WWTP contributes around 40 percent of nitrogen loads and 60 percent of phosphorus loads. In the Upper Logan and Mid-Brisbane clusters there are only two point source loads, while there are no WWTPs in the Lower Logan cluster. In the Upper Brisbane/Bremer cluster no single source dominates point source loads, but only 5 significant sources were identified.

The merits of the clusters were discussed at a workshop in June. The participants identified the Bramble Bay and Lower Logan clusters as the most promising for further evaluation. The merits of these clusters are discussed below.

4.2.1 Bramble Bay Cluster

The original Bramble Bay cluster was defined as the Pine River Estuary, Cabbage Tree Creek Estuary and Lower Brisbane Estuary. Within these estuaries point sources are considered likely to have equivalent environmental impacts. The original cluster included seven WWTPs (four in the lower Brisbane catchment and three in the Pine catchment), two oil refineries, a fertiliser works and a papermill.

At the workshop we discussed the possibility of including additional licensed sources, the potential benefits for trade of including these additional sources as well as likely challenges in establishing environmental equivalence for sources further from Bramble Bay. A number of additional sources were identified in the lower Brisbane and Pine catchments that could be investigated as part of the cluster. These included Fairfield WWTP, Oxley Creek WWTP and Wynnum WWTP. These sources are not likely to have a 1:1 environmental equivalence with the other sources in the cluster and this would need to be accounted for in any trading arrangements.

Table 12 shows the full list of point sources in the revised Bramble Bay cluster, the location of their discharges and their percentage contribution to current nutrient loads from the point sources.

Table 12: Point sources in revised Bramble Bay cluster

Point sources	% of total point source loads		Location of discharge
	Nitrogen	Phosphorus	
<i>Wastewater Treatment Plants</i>			
Redcliffe	1.26	0.55	Hayes Inlet
Murrumba Downs	2.23	4.53	North Pine River
Brendale	1.12	0.54	South Pine River
Sandgate	13.57	10.92	Cabbage Tree Creek
Nudgee	0.03	0.00	Nudgee Creek
Luggage Point	18.91	48.02	Brisbane River
Gibson Island	3.59	12.91	Brisbane River
Fairfield	2.09	0.83	Brisbane River
Oxley Creek	48.86	17.36	Brisbane River
Wynnum	4.87	3.97	Moreton Bay
<i>Other Licensed premises</i>			
Amcor paper mill	1.03	0.10	North Pine River
BP oil refinery	0.18	0.19	Brisbane River
Caltex oil refinery	0.32	0.04	Brisbane River
Incitec fertiliser works	1.94	0.04	Aquarium Passage

WWTPs dominate point source loads and would therefore be key participants in a trading scheme. Table 13 outlines the characteristics of the WWTPs in the revised Bramble Bay cluster. The greater the diversity in size and current treatment levels, the greater diversity you would expect in the costs of further upgrades to reduce nutrient loads.

Table 13: Characteristics of the WWTPs in the revised Bramble Bay cluster

	Range of values
Share of total point source nitrogen load	<1% - 49%
Share of total point source phosphorus load	<1% - 48%
Size of WWTP (ML/day)*	<16 – 130
Average nitrogen discharge concentration (mg/L)*	3.08 – 5.6
Average phosphorus discharge concentration (mg/L)*	4.97 – 9.09

* reported for WWTPs contributing greater than 5 percent of total point source load

Note: where there is an upgrade underway – the estimated concentration at the end of the upgrade is reported in the table for the purpose of considering potential benefits of trade in the future.

There is diversity in the size and treatment levels of the WWTPs in the cluster. There are some big differences in discharge concentrations, particularly for phosphorus. The discharge concentrations are more similar for nitrogen, as this has been a common focus of recent improvements. However, the treatment levels for nitrogen still range from 3 mg/L to 5.6 mg/L.

The diffuse sources in the Bramble Bay cluster include stormwater from urban areas around both the Brisbane and Pine River estuaries as well as rural runoff in the Pine rivers estuary and catchment. Agricultural activities make a significant contribution to nitrogen loads in the Pine catchment (around 36 percent). However, the environmental impact of some activities in the upper Pine catchment may be much lower than the point sources and trading between the sources may not be worthwhile. The closer the activity to the estuaries, the greater is the likely environmental equivalence and potential benefits from trade. While the total loads or numbers of agricultural activities in different parts of the Pine catchment is unknown, the Pine Rivers Catchment Association has advised that there are significant opportunities to reduce nutrient loads from cattle grazing and horse hobby farms around the edge of the Pine Rivers estuary, including around the Ramsar listed Hayes Inlet. Riparian rehabilitation projects have recently been carried out in Armstrong Creek and Dorset Creek. There is also potential for a pilot trading scheme to link with or build upon the existing Pilot Riparian Management Incentive Scheme in the catchment.

4.2.2 Lower Logan Cluster

The Lower Logan cluster was originally defined as the Lower Logan estuary and part of Southern Moreton Bay. In the original cluster there are 11 prawn farms. Together they discharge around 13,000 kilograms per year of nitrogen and 385 kilograms per year of phosphorus. They make a small overall contribution to loads in Moreton Bay, however seasonal, high concentration loads can significantly influence water quality and there is pressure for expansion of their activities. A trading instrument could be used to allow new entrants into the industry without increasing nutrient loads. However, the outcome for Moreton

Bay would be much less significant compared with capping/reducing nutrient loads in Bramble Bay.

A trading instrument among the prawn farms may well be suitable to manage new entrants into the industry in the Lower Logan estuary without increasing overall nutrient loads. However, it is not considered suitable as the nutrient trading pilot for Moreton Bay. It is recommended that the EPA consider the potential for such a scheme separately.

At the workshop we considered expanding the Logan cluster to include point sources in the Upper Logan estuary, Albert estuary and in the upper catchment areas. Table 14 shows the point sources in the revised Logan cluster, the location of their discharges and their percentage contribution to current nutrient loads.

Table 14: Point sources in revised Logan Albert cluster

Point sources	% of total point source loads		Location of discharge
	Nitrogen	Phosphorus	
Prawn farms	14	0.5	Lower Logan estuary
Loganholme WWTP	58	89	Upper Logan Estuary
Beenleigh WWTP	19	6	Albert estuary
Beaudesert WWTP	8	4	Canungra Creek - Upper Logan/Albert catchment
Canungra WWTP	1	0.5	Upper Logan/Albert catchment
Mount Cotton WWTP	1	0.1	Upper Logan/Albert catchment

Again, WWTPs dominate point source loads. Table 15 outlines the characteristics of the WWTPs in the revised Logan Albert cluster.

There is diversity in the size and treatment levels of the WWTPs in the cluster. The greatest difference in discharge concentrations is for nitrogen, with values ranging from 4 mg/L to 20 mg/L.

Diffuse sources in the revised Logan Albert cluster include stormwater runoff from urban areas in Logan and Beenleigh, as well as Beaudesert where significant new urban development is expected. In the upper catchment there are extensive areas of grazing lands, as well as dairying and irrigated agriculture. In the Lower Logan there are cane farms and drains.

Table 15: Characteristics of the WWTPs in the revised Logan Albert cluster

	Range of values
Share of total point source nitrogen load	1 - 58
Share of total point source phosphorus load	<1 - 89
Size of WWTP (ML/day)*	<1 – 37
Average nitrogen discharge concentration (mg/L)*	4 – 20
Average phosphorus discharge concentration (mg/L)*	1 – 5

* reported for WWTPs contributing greater than 5 percent of total point source load

Note: where there is an upgrade underway – the estimated concentration at the end of the upgrade is reported in the table for the purpose of considering potential benefits of trade in the future.

4.3 Bramble Bay nutrient trading pilot recommended

There is a much greater spread of loads among point sources in the revised Bramble Bay cluster compared to the Logan Albert cluster. A trading instrument could be used in the Logan Albert cluster, however there is limited potential for point to point source trading. In addition, the seasonal nature of discharges from prawn farms compared to the steady flow from WWTPs would introduce complications in determining environmental equivalence between point sources. The Loganholme WWTP dominates the pollutant loads and its share will become greater as significant reuse is planned for Beaudesert WWTP. While not all point sources in the Bramble Bay cluster would necessarily have a 1:1 environmental equivalence, the discharges from the WWTPs are at least similar in nature.

There are opportunities for diffuse source offsets in both the Bramble Bay and Logan Albert clusters. There are likely to be more opportunities for urban stormwater offsets in Bramble Bay and for agricultural offsets in the Logan Albert cluster. However, it appears that there are likely to be opportunities to gain experience across both types of diffuse sources in each of the clusters.

An offset scheme could be used to reduce the costs of Loganholme WWTP meeting new nutrient targets, however, this offers a far more limited pilot and opportunity for developing expertise with trading instruments, than the Bramble Bay cluster.

5. DECIDING ON A TRADING STRUCTURE

This section begins with consideration of nutrient sources and strategic factors to develop a short-list of potential trading structures. The merits of these trading structures will primarily be distinguished by the potential benefits of trade that they offer, which in turn reflects the diversity of nutrient abatement costs among sources in the pilot region. As a guide to the likely diversity of costs, section 5.2 identifies nutrient abatement costs drawing on experiences in other States and across SEQ. Section 5.3 then considers specific nutrient abatement and trading opportunities in the revised Bramble Bay cluster. Finally, in Section 5.4 an assessment of the most promising trading structure for nutrients in Bramble Bay is presented.

5.1 Identifying a short-list of trading structures

The merits of each catchment for a tradeable nutrient scheme will depend on the market structure proposed. Table 1 provided a description of the key types of tradeable rights schemes. Some of the tradeable discharge rights options are not applicable in the SEQ context. Fee offsets are not an option as there are no pollution discharge fees currently paid by regulated activities. Licensing offsets are also unsuitable, given that they are opportunistic and do not fit in with the broader strategic plan to reduce loads in targeted areas of SEQ.

A point and diffuse source trading scheme (with targets or caps on diffuse sources) would require statutory limits on diffuse sources. As discussed in section 3.5 in the context of sediment loads from diffuse sources, this would pose several problems, namely:

- Present significant risks as there is no international experiences to draw on;
- Mean much greater difficulty in establishing robust equivalence ratios, due to uncertainties in estimating nutrient generation rates from different sources and management practices, spatial and temporal differences between diffuse sources, as well as chemical composition and transport issues;
- Impose significant costs on regulators and the diffuse sources in identifying current loads, allocating load liabilities, and in monitoring and enforcing compliance; and
- Pose significant stakeholder issues similar to those faced in the US when trying to introduce regulatory requirements on diffuse and largely rural sources.

Therefore our focus has been limited to point source trading options and options that may include voluntary diffuse source offsets. That is, bubble schemes, permit trading schemes, and either of these incorporating offsets.

Bubble schemes involve setting an overall pollution limit over a small number of regulated point sources, and allowing them to trade abatement effort. Because of the small number of participants, they can enter into their own bilateral arrangements for improvements subject to the agreement of the environmental regulator and the incorporation of agreed discharge loads into regulated load limits. This will be easiest where the sources are owned by the same entity and discharges are controlled under the same statute, such as via EPA licenses – this is the

situation with the South Creek Bubble Licence administered by the NSW EPA and involving 3 WWTPs operated by Sydney Water.

For the point sources in the Bramble Bay cluster, all are regulated by the Qld EPA. For these activities, any reduction in current loads could be introduced through current licensing powers. Similarly, anticipated growth in point source loads will be from these currently licensed activities or activities that would be required to obtain a license from the EPA. Therefore a bubble trading scheme could be implemented under EPA legislation without the need for supporting changes to planning or other legislation. In addition, a significant proportion of nutrient loads come from WWTPs operated by Brisbane Water. This presents the potential for a Bubble License similar to that applicable to Sydney Water.

However where the number of participants increases, administration costs will also increase, and the work involved for participants to identify mutually advantageous exchanges will become greater. In these circumstances, more formal trading arrangements offered in permit trading schemes are likely to be superior. With fourteen point sources of nutrients in the revised Bramble Bay cluster and seven different responsible entities (Brisbane Water, Pine Rivers Shire Council, Purac Pty Ltd, BP, Caltex, Incitec and Amcor), there may be benefits in establishing a more formal trading scheme.

Point source permit trading schemes involve placing a cap on the overall load of pollutants discharged from a wider set of participating point sources, allocating tradeable permits and only allowing discharges commensurate with permit holdings. The option is attractive given the number of sources and likely diversity of abatement costs in the cluster. The scheme would involve setting aggregate reduction targets for nitrogen and for phosphorous, with each target applicable to total discharges from the fourteen EPA licensees. Discharge permits equivalent to the discharge limits would need to be allocated across the licensees and trading amongst them allowed subject to a set of rules. However, trading schemes require significant developmental and administrative work and are generally pursued where the expected gains from trade are large. For example, the US EPA spent \$44m over five years on the acid rain program in the US, as well as providing \$18.9m to State and local government for implementation¹¹. At a minimum, the additional benefits from trade offered by moving from a bubble scheme to a formal permit trading scheme should be greater than the additional regulatory and compliance costs involved.

A bubble or permit trading scheme, with offsets allows trading with point or diffuse sources not included in the bubble limit or trading cap. These sources would be able to voluntarily enter into arrangements to sell approved nutrient reduction “credits” to regulated sources in the scheme.

The option of including offset trading is also attractive as it could provide access to low cost nutrient abatement, particularly from diffuse sources. Diffuse sources constitute a major part of total loads and are of strategic interest to Government given the limited success or budget

¹¹ US EPA (1996) Evolution of marketable permits: The US experience with sulfur dioxide allowance trading, International Journal of Environmental Pollution.

demands of alternative policy approaches used by governments to date. For example, while approaches like incentives schemes have been useful in improving knowledge of diffuse sources and abatement measures they have not been successful in achieving widespread reductions in diffuse pollution. It should be noted however, that the inclusion of offset arrangements will involve significant extra work and on-going regulatory support, and so the benefits offered need to exceed the costs involved.

Beyond consideration of which market structure offers the greatest benefits by way of lower nutrient abatement costs, Governments will have other specific policy considerations that need to be considered in choosing a market structure and designing its operational parameters.

The first of these is the extent to which the pilot must deliver demonstrable environmental gains. The Queensland Government must consider the trade-off between investments that will deliver short term benefits to that of investing in knowledge creation for longer term gains. In Section 3, experiences with nutrient trading schemes are presented, that illustrates mixed success. The Government will need to consider the extent to which a more conservative scheme design will increase the likelihood of the pilot generating demonstrable reductions in pollutant loads to Moreton Bay, with that of the potential for developing a better understanding of nutrient trading mechanisms with a more expansive scheme.

The likelihood of the pilot being successful raises a second issue. A successful scheme will garner stakeholder support for further use of these instruments. Again, a more conservative scheme design will increase the likelihood of a successful pilot, but it may not maximise learning opportunities that may be afforded with a more expansive scheme.

Indeed experiences in the US, both for air and water emission trading, demonstrate an “evolution” of trading instruments from opportunistic point source to point source offsets, to more expansive permit trading schemes and the subsequent inclusion of voluntary diffuse source offsets. The mandatory inclusion of diffuse sources in trading schemes has been the focus of recent court challenges and the prescription of statutory nutrient discharge limits on diffuse sources is only just being incorporated in trading structures. This evolution has been critical to fostering a cultural change among stakeholders, developing the scientific and regulatory skills to support trading and in garnering political support for more expansive schemes. For similar reasons, a third policy consideration is whether it would be prudent to adopt a strategy of a planned evolution of nutrient trading in SEQ rather than the first pilot scheme imposing unrealistic imposts on government and participants.

Each of these strategic issues gives weight to choosing a less expansive, less complicated market structure. For our short-listed market structures, this would place a bubble scheme ahead of a permit trading scheme which in turn would be positioned ahead of a scheme involving offset trading. In selecting a market structure, these arguments for “conservatism” will need to be weighed against the potential for greater learning opportunities and trading benefits with more expansive scheme designs.

5.2 Nutrient abatement costs in Australia

Investigations into the cost of abating nutrients have been carried out recently for other Australian catchments. These include the South Creek catchment in New South Wales, Port Adelaide Waterways in South Australia and Port Phillip Bay in Victoria. The greater the diversity of costs of abatement, the greater the potential benefits of trade among different sources. In each catchment, the cheapest measure identified was implementing best management practices at horticultural activities (primarily improving fertiliser practices). The relative costs of other options vary across the catchments. Table 16 compares the cost-effectiveness of abatement actions in South Creek, Port Phillip Bay and Port Adelaide Waterways catchment.

Table 16: Cost-effectiveness of abatement actions in other States to reduce nitrogen

Abatement measure to reduce nitrogen	South Creek, NSW (\$/kg/yr)	Port Phillip Bay, VIC (\$/kg/yr)	Port Waterways, SA (\$/kg/yr)
<i>Urban sources</i>			
Constructed wetlands	\$10	\$80	\$40-\$80
Better treatment at WWTPs	\$10,000	\$50	\$200
Other point sources	-	-	\$12
<i>Agricultural sources</i>			
Modifying fertilizer use by horticulture	< \$5	< \$5	-
Riparian restoration	\$10	-	< \$5
Buffer strips on horticultural land	< \$15	-	-
Best practice for cropping	-	\$55	-
Best practice for grazing	-	\$75	-

Sources: *Pollution Reduction Trading Scheme for South Creek – Pilot Proposal*, October 2002, NSW EPA, *Economic benefits of nutrient load reduction in the Port Phillip Catchment – Scoping Study*, Read Sturgess & Associates, January 2001, *Tradeable discharge rights to reduce nutrient pollution in the Port Waterways Catchment*, BDA Group, June 2004

In South Creek, NSW, nutrient abatement from agricultural sources was estimated to be much cheaper than from WWTPs. For nitrogen the marginal costs of reducing abatement from WWTPs was expected to be 1,000 times the cost of reductions at diffuse sources.

For the Port Phillip catchment, reducing nutrients in runoff from urban areas was identified as the most expensive option. The relativities between costs of options are similar for both nitrogen and phosphorus. In this catchment reductions from WWTPs were cheaper than many of the diffuse source abatement actions (such as implementing best management practice on grazing and cropping land and constructed wetlands in urban areas). Only implementing best

management practices and buffer strips on horticultural lands was estimated to be cheaper than reducing nutrients from WWTPs.

It should be noted that the WWTPs reduction costs are not an average or weighted average across all WWTPs discharging into Port Phillip Bay. They represent only the cost of upgrades to municipal WWTPs (and exclude for example the costs of upgrading the Western Treatment Plant). They are therefore much cheaper than the WWTPs costs in other States.

In the Port Waterways catchment in SA the most expensive option for reducing nitrogen was further treatment of WWTPs discharges and the most expensive option for reducing phosphorus was implementing wetlands to reduce runoff in urban areas.

The experience in other States suggests that measures to reduce nutrients from intensive agriculture in SEQ are likely to be much cheaper compared with other sources. The relative attractiveness of reducing nutrients from other diffuse sources is likely to depend on the costs at WWTPs (which in turn are influenced by their size, existing infrastructure and current treatment levels).

An analysis of the likely cost-effectiveness of reducing nutrients from point and diffuse sources in SEQ was undertaken in March 2005 by the Central Queensland University for the Queensland EPA. The results are summarised in Table 17.

The point source cost estimates in the table were based on local government forward estimates for planned works. Fifty per cent of the costs were assumed to be allocated to WWTP upgrades to deal with anticipated population growth and the other 50 percent was assumed to be allocated to reducing sewage nutrient emissions to SEQ waterways.

Table 17: Cost Effectiveness of Point and Diffuse Source Load Intervention Strategies in SEQ

Pollution Load	Average Annual Cost of <u>Point</u> Source Load Reduction \$/tonne/yr	Average Annual Cost of <u>Diffuse</u> Source Load Reduction \$/tonne/yr
Nitrogen	\$6,729	\$8,553
Phosphorus	\$5,400	\$39,735

Source: Institute for Sustainable Regional Development, 2005

The cost-effectiveness estimates group diffuse agricultural abatement actions together with retrofitting best practice water quality measures to existing urban and rural residential land in the SEQ region. The agricultural actions included are grassed riparian filter strips for 1st and 2nd order streams in the SEQ region and riparian rehabilitation strips in half of the region's 2nd order streams, all 3rd order streams and half the 4th order streams.

This analysis assumes that the filter strips would be applied across the whole SEQ region – rather than in any targeted way searching for opportunities where costs would be low.

However the rationale of using a trading instrument is to ensure there is an incentive to implement the measures only in instances where effectiveness is likely to be high and costs low. It is likely that the costs of actions to address nutrients from agriculture are likely to be lower than the average reported above which includes urban abatement measures. In particular, filter strips and riparian work to address the impacts of intensive agricultural activities are likely to be much more cost-effective than suggested by the reported data.

Because the figures above are averages across different abatement measures as well as locations within SEQ, they are of limited use for assessing likely cost differentials. You would expect variation in WWTP abatement costs depending on the size, existing infrastructure and current treatment levels of different WWTPs. Also, the costs of diffuse abatement measures are also likely to vary across geographical areas depending on the characteristics of the landscape.

Based on experience elsewhere it is highly likely there will be opportunities in SEQ to reduce nutrients from agricultural sources at low cost, relative to at least some WWTPs. More disaggregated data is required to determine the extent of such opportunities, and this has been our focus for the Bramble Bay cluster.

5.3 Nutrient abatement in Bramble Bay

This section examines ways to reduce nutrients beyond existing programs, including point and diffuse source abatement actions and their cost-effectiveness. Note that the cost estimates included in this section are very preliminary. The available estimates are used to gain an appreciation of the likely relativity of costs between options as a step towards estimating the potential benefits from trading nutrient abatement effort.

5.3.1 Wastewater treatment plants

The options currently available to the WWTPs to reduce nutrient loads are:

- Better treatment of effluent
- Reuse of effluent for internal purposes
- External reuse of effluent

Many of the WWTPs in the Bramble Bay cluster have load limits for nitrogen discharges. Table 18 compares current nitrogen loads with current and future load limits, while the location of the WWTPs and other point sources are shown in Figure 13.

Figure 13 : Location of point sources in Bramble Bay Cluster



Table 18: Regulatory requirements relating to nitrogen loads for WWTPs in Bramble Bay (tonnes per year) *

WWTP	2003-04 load	Current load limit	2009 load limit
Sandgate	195	267	46
Nudgee	0.4	1	0.4
Luggage Point	272	562	274
Gibson Island	52	88	91
Fairfield	30	43	12
Oxley Creek	703	1,100	122
Wynnum	70	105	14
Redcliffe	18	No limit	No limit
Murrumba Downs	32	No limit	No limit
Brendale	16	No limit	No limit
Total	1,388	2,232*	625*
% of 2003-04 load		161%	45%

* Assumes discharges from WWTPs with no limit remaining at current levels

Load limits have typically not been constraining, and as is the case with Gibson Island, increases can be negotiated to accommodate anticipated load increases with urban development. The current load limit for the Bramble Bay WWTPs is some 161 percent of current discharges.

As shown in Table 18, there are currently regulatory requirements to reduce nutrient loads at a number of WWTPs. Upgrades are currently underway at Sandgate and Oxley Creek to reduce their average discharge concentration of nitrogen to 5 mg/L, with load limits to be reduced accordingly. The upgrades are due for completion in mid 2006. There is also a license requirement and planned upgrade for Wynnum WWTP to reach a similar treatment level for nitrogen by 2008.

Other licence requirements to reduce current or future nutrient loads (where an upgrade is not already underway) include:

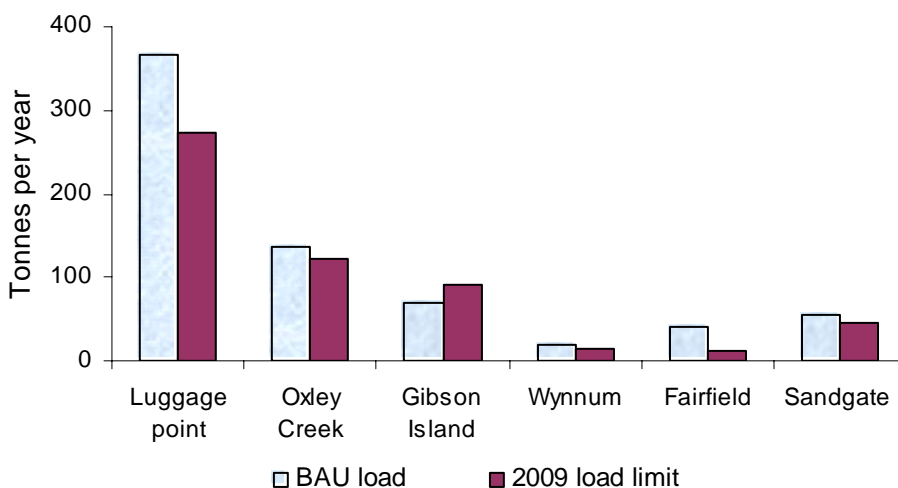
- Sandgate – has a licence condition requiring the average discharge concentration for phosphorus to be reduced to 2 mg/L by 2009 (it is currently around 9 mg/L). However, the licence condition does not need to be met if it can be demonstrated by scientific evaluation that this is not required.
- Oxley Creek - has a similar licence condition to Sandgate requiring the average discharge concentration for phosphorus to be reduced to 2 mg/L by 2009 (it is currently

around 5.5 mg/L). Similarly, the condition does not need to be met if it can be demonstrated by scientific evaluation that this is not required.

- Fairfield - has a licence condition requiring the average discharge concentration for nitrogen to be reduced to 12 mg/L by 2008 (it is currently around 32 mg/L) resulting in a reduction in the current annual load of 55 percent.
- Murrumba Downs – is having difficulty meeting its current requirements for long term 50th percentile compliance of 2 mg/L for phosphorus (current average discharge concentration is 5 mg/L). Murrumba Downs has a voluntary environmental management program in place to determine and implement an appropriate method of phosphorus reduction to demonstrate that the requirements are met by 2006.
- Brendale – is having difficulty meeting its current requirements for long term 50th percentile compliance of 1 mg/L for phosphorus (current average discharge concentration is 1.2 mg/L). Brendale also has a voluntary environmental management program in place to determine and implement an appropriate method of phosphorus reduction to demonstrate that the requirements are met by 2006.

Under a business as usual scenario there will be pressure for WWTPs to meet future load limits as their volumes of wastewater increase. Figure 14 compares projected loads under business as usual with future nitrogen load limits.¹²

Figure 14: Comparison between 2026 nitrogen loads under a “business-as-usual” scenario and relative to 2009 load limits



All WWTPs with load limits will be under pressure to meet future nitrogen load limits under a business as usual scenario, except for Gibson Island which has been granted an increase in its future load limit.

For phosphorus, Table 19 shows relevant regulatory requirements.

¹² Table A2.1 in Appendix 2 provides a table showing the specific year 2026 BAU forecasts.

Table 19: Regulatory requirements relating to phosphorus loads for WWTPs in Bramble Bay (tonnes per year)

WWTP	2026 phosphorus load under BAU	2009 load limit or equivalent ^{1,2}
Sandgate WWTP	76	18
Oxley Creek WWTP	150	50
Murrumba Downs WWTP	40	16
Brendale WWTP	5	4

¹ Limits for Sandgate and Oxley Creek do not need to be met if it can be demonstrated by scientific evaluation that this is not required

² Murrumba Downs and Brendale do not have load limits for phosphorus, the table shows the equivalent load if their current concentration limits were met

The table shows that total phosphorus reductions of around 160 tonnes per year could be required from Sandgate and Oxley Creek to meet future requirements.

The costs of recent upgrades by SEQ WWTPs can be used as a guide to future costs, taking into account the size of the WWTP, the level of treatment before and after the upgrade, the existing infrastructure and proposed treatment method. Table 20 shows the estimated cost effectiveness of some past upgrades in SEQ.

Table 20: Cost Effectiveness of WWTP upgrades in SEQ¹³

WWTP upgraded	Total cost (\$m)	Cost effectiveness (\$/t/yr)	
		Nitrogen	Phosphorus
Luggage Point	25	30,000	-
Goodna	0.39	10,000	40,000
Bundamba	15	280,000	290,000
Rosewood	0.78	340,000	-
Maroochy	28 ¹	600,000	700,000
Murrumba Downs	8.3 ²	300,000	780,000
Brendale	3.5 ³	285,000	1,600,000

Sources: *Wastewater Futures Pty Ltd, 2005* and 2003 upgrade summaries provided by Ipswich Council

¹ The total cost was \$31m, 25 percent has been attributed to expansion of capacity (of 25 percent)

¹³ Table also assumes Brendale WWTP effluent concentrations were at licence limits before upgrade, and assumes Murrumba Downs effluent was around 10 mg/L N and 7 mg/L P before upgrades

- 2 The total cost was \$10m, 17 percent has been attributed to expansion of capacity (of 17 percent)
- 3 The total cost was \$7m, 50 percent has been attributed to expansion of capacity (of 50 percent)

The upgrade to Luggage Point and Goodna WWTPs were the cheapest per tonne and were considered to be very cost-effective because changes to existing infrastructure was all that was needed to achieve better quality effluent.

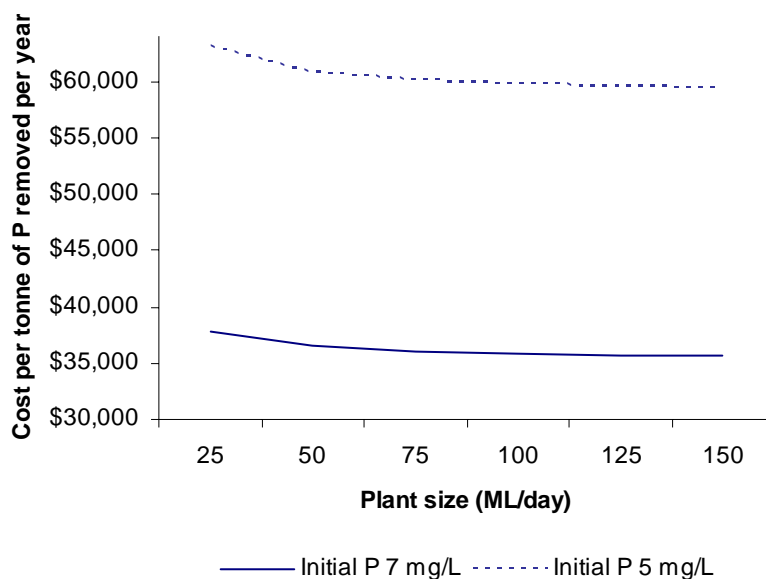
The costs of options to reduce nutrients from WWTPs in the future depend on a number of factors including the current concentrations of nutrients in effluent, the size of the plant and the existing infrastructure. Brisbane Water is currently evaluating options for phosphorus removal at their WWTPs and the cost estimates presented in this report draw on this work. Appendix 3 provides more background on development of the cost estimates. While there are many alternative options for reducing nutrients – three specific options are used in this report to provide an indication of the likely magnitude of costs. The options are:

- Metal salt dosing to reduce phosphorus
- Lime dosing to reduce phosphorus
- Tertiary filtration to reduce nitrogen

The relationships discussed below and described further in Appendix 3 are used to provide estimates for individual WWTPs in Bramble Bay in section 5.4.

It is assumed that metal salt dosing can achieve a phosphorus concentration in effluent of 2 mg/L and that the capital costs would be around \$0.5m for a large plant. Figure 15 below shows preliminary estimates of the cost effectiveness of metal salt dosing for plants of various sizes and starting concentrations.

Figure 15: Estimated cost-effectiveness of metal salt dosing to reduce phosphorus



The cost estimates reported in the figure are present value total costs over a 20 year period (including capital cost plus the present value of expected annual operating costs over 20 years). Cost-effectiveness is calculated as the total cost divided by the annual reduction in tonnes of nutrients in discharges.

Figure 15 shows that the cost-effectiveness of metal salt dosing is not expected to vary much across different plants sizes, however it does vary with the starting effluent concentration reflecting the magnitude of the loads reduced.

An alternative option for phosphorus removal is lime dosing with additional tertiary filtration. Lime dosing is expected to be able to reduce phosphorus concentration in effluent to around 0.5 mg/L. This option is more expensive with capital costs of around \$20m for a large plant. The cost-effectiveness is estimated to be higher than metal salt dosing, ranging from around \$75,000 per tonne of phosphorus removed per year (for a 150 ML/day plant) to \$130,000 (for a 25 ML/day plant) assuming the original phosphorus concentrations in effluent are around 7 mg/L.

Tertiary filtration to reduce nitrogen is expected to achieve a concentration of 2 mg/L. Figure 16 shows estimates of the cost-effectiveness of this option.

Figure 16: Estimated cost-effectiveness of tertiary filtration to reduce nitrogen

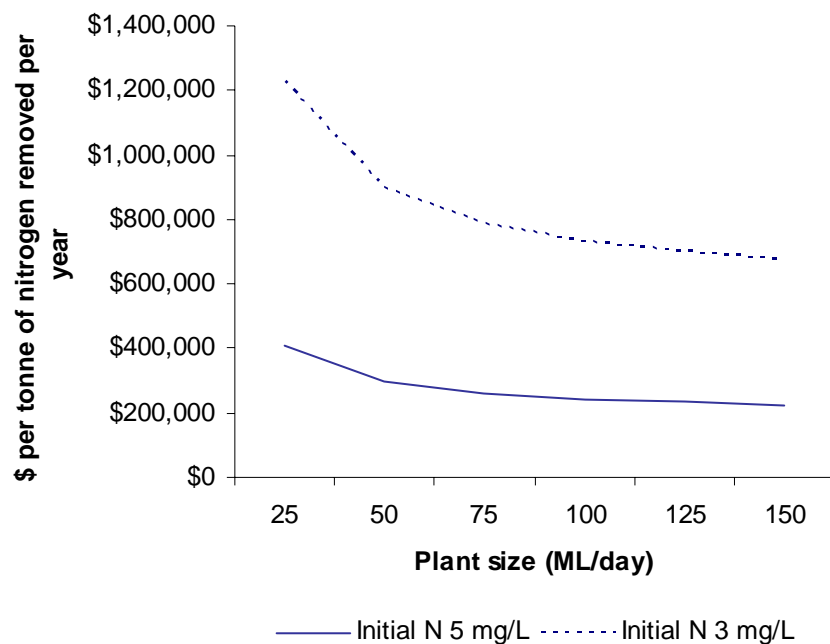


Figure 16 shows that there is likely to be significant variation in the costs of reducing nitrogen across plant sizes due to the large capital investment required.

Reuse of effluent is another option that can result in a reduction in nutrient load. There is both internal reuse and some external reuse of effluent from WWTPs in SEQ. The BP Refinery at Bulwer Island reuses wastewater from Luggage Point WWTP for their cooling towers and

boilers. While the arrangement has water conservation benefits it does not reduce nutrient loads entering Moreton Bay. Both in the lower Brisbane and Pine catchments effluent is reused on sporting fields, golf courses and in council operations, with these practices largely utilising the nutrients in the effluent and hence representing a reduction in nutrient loads entering Moreton Bay.

The costs of reuse schemes are highly dependent on the project. The initial proposal for the SEQ recycled water project was estimated to cost \$790 million to construct and around \$20 million per year to operate. The project was to deliver treated effluent to irrigators in the Warrill, Bremer, Lockyer Valleys and Darling Downs. However, the amount the farmers were prepared to pay was only enough to cover the operation and maintenance costs (Wastewater Futures 2005).

The Carole Park Wastewater Centre Effluent Reuse Scheme cost around \$980,000 in 1997-98 and provided reductions in nitrogen loads of around 2 tonnes per year of nitrogen and 1 tonne per year of phosphorus. A wastewater recycling centre is now planned at the new Western WWTP near Ebenezer with construction scheduled for 2011-12. It is based on 100 percent reuse. However, there are no estimates of cost available at this stage.

Within the Bramble Bay cluster, reuse of the effluent from Fairfield WWTP by golf courses is currently under consideration as a means of meeting their licence requirements in future.

5.3.2 Other licensed sources

There may be scope to reduce loads from the other point sources, given that the recent focus has been on reducing nitrogen from the WWTPs. Incitec has a significant share of nitrogen loads (at 2 percent of total point source loads in the Bramble Bay cluster). Table 21 shows relevant regulatory requirements for the other licensed sources.

Table 21: Regulatory requirements for nutrient loads from other licensed sources in Bramble Bay Cluster (tonnes per year)

Source	2003-04 load	Current load limit
<i>Nitrogen</i>		
BP	3	13
Caltex	5	11
Incitec	28	128
Amcor	15	40
<i>Phosphorus</i>		
BP	1	No limit
Caltex	0.3	28
Incitec	0.3	No limit

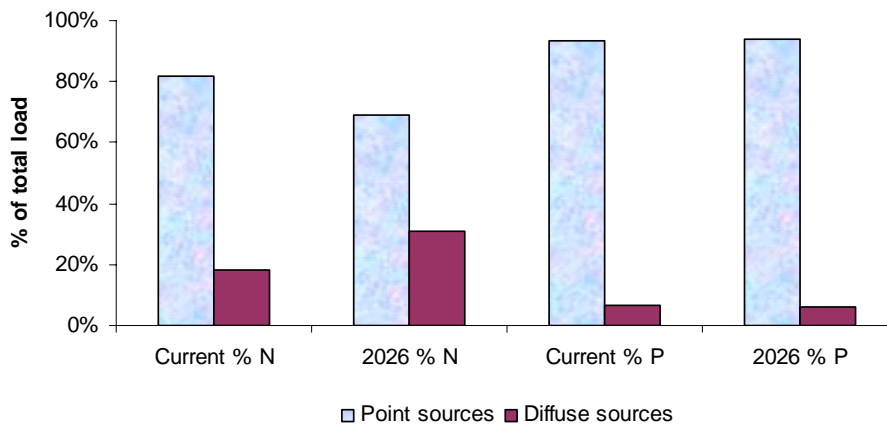
Ampcor	0.6	3.6
--------	-----	-----

There is no information available at this time on methods for or costs of reducing nutrients from Incitec or the other point sources.

5.3.3 Diffuse sources

This section examines the contribution of diffuse loads in Bramble Bay and the likely breakdown of different types of diffuse loads in the Bramble Bay cluster, as well as examining the possible options for nutrient reduction. Figure 17 below shows the contribution of diffuse nutrient loads in Bramble Bay now and in the future.

Figure 17: Shares of diffuse nutrient loads in Bramble Bay now and in the future



The significance of the various types of diffuse sources in the Bramble Bay cluster area is shown in Figures 18 and 19. These are very preliminary estimates only as they assume an even distribution of land use activities across the Lower Brisbane and Pine Rivers catchments.

Figure 18: Bramble Bay Cluster diffuse source nitrogen loads

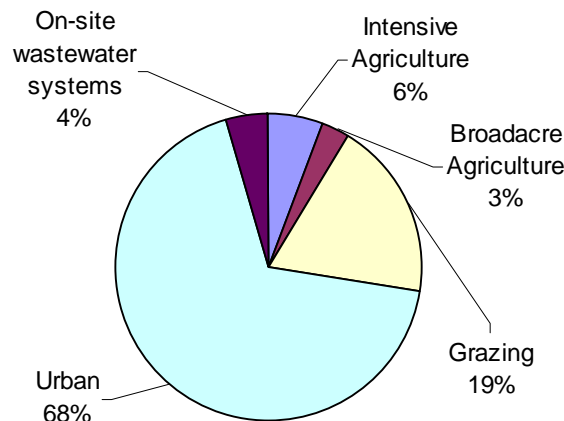
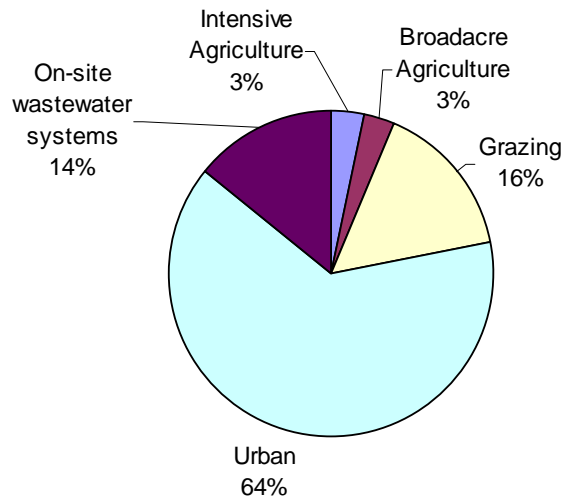


Figure 19: Bramble Bay Cluster diffuse source phosphorous loads



There are a range of options available for reducing nutrients from urban stormwater, from structural measures to programs focused on behavioural changes. Some of these abatement actions have been implemented by Brisbane City Council as part of their urban stormwater management strategy (1999).

A 2002 report by Brisbane City Council provides some information on reducing pollution from urban stormwater. The key measure with the potential to reduce nutrients is wetlands, with an estimated cost of \$750,000 (total life cycle cost). Wetlands are designed to remove around 80 percent of nitrogen and 60-70 percent of phosphorus loads. WBM Oceanics Australia recently collected information on the costs of diffuse source best management practices for the Moreton Bay Waterways and Catchments Partnership. Table 22 summarises the results for diffuse source abatement actions focusing on nutrient reductions. More information is needed on the areas where these measures could potentially be applied and the baseline nutrient generation from these areas in order to estimate potential reductions in \$ per tonne of nitrogen or phosphorus.

Septic systems can also be a significant diffuse source of nutrients. In both the Brisbane and Pine catchments septic systems are estimated to contribute over 20,000 kg of nitrogen per year and over 10,000 kg of phosphorus (Beal et al 2003). Both councils have a policy in place relating to the management of septic systems. The Pine Rivers Shire Council requires a nutrient balance as well as a water balance for systems within the dam catchment. There may be future opportunities to reduce nutrients from this source.

Table 22: Outcomes of BMP review

BMP for agriculture	Performance (pollutant removal)	Cost
Gully treatment	-	\$5,000-50,000/km
Riparian buffers	56-91% N 10-93% P	\$6,540/ha establish \$1,150/ha ongoing
Livestock exclusion	-	\$1,200-\$2,200
Diversion banks and grassed waterways	50 % N 70% P	\$440/ha/yr establish \$100/ha/yr maintenance which will vary depending on slope
Contour banks	5-12% N&P	US\$16.4/m establish 20% maintenance

Source: *Diffuse Source Best Management Practices: Review of Efficacy and Costs*, WBM Oceanics, 2005

A recent report by Ecological Engineering estimates the cost and likely outcomes of seven design options for reducing stormwater runoff from a hypothetical residential development. The development chosen was a 1.368 hectare greenfield medium density development. The wetlands in the study were assumed to have surface areas of 12 hectares (for the large, regional one) and 1.2 hectares (for the small, local one) and detention times of 24 hours. Their effectiveness in removing nutrients was assumed to be 45 percent for both nitrogen and phosphorus.

The results are summarised in Table 23. The large regional constructed wetland was the most cost-effective option examined for reducing nutrients – with a cost of around \$17,000 per kg per year of nitrogen. The estimated cost-effectiveness of wetlands for nutrient removal in Brisbane is much higher than has been estimated for some other States. This is likely to be due to the scale of the wetlands examined, for example the hypothetical wetland used for the SA estimate in Table 16 was estimated to cost around 10 times that of the large regional constructed wetland in Table 23.

Table 23: Estimated cost-effectiveness of urban stormwater projects for Brisbane (\$/kg/yr)

Urban stormwater project	Cost-effectiveness	
	Nitrogen	Phosphorus
Large regional constructed wetland	\$17,000	\$74,000
Small local constructed wetland	\$21,000	\$94,000
Range of other bioretention systems	\$31,000-\$51,000	\$121,000-\$182,000

Source: Estimates derived from *Triple Bottom Line Assessment Project, MUSIC Modelling Tasks*, prepared by Ecological Engineering for CRC for Catchment Hydrology, July 2005.

The cost of the urban stormwater projects are much greater per tonne than the costs of recent WWTP upgrades shown in Table 20. The WWTP upgrade costs ranged from \$10,000 per tonne to \$1.6m per tonne of nutrient reduced, compared with the urban stormwater projects costing \$17m per tonne to \$121m per tonne of nutrients.

5.4 Trading benefits of alternative market structures

There are three main options for a trading instrument for Bramble Bay:

- Option 1 - Bubble trading scheme
- Option 2 – Point source permit trading scheme
- Option 3 – Bubble or permit trading scheme with offsets

A bubble trading scheme for Brisbane Water is attractive, given that a significant proportion of nutrient loads come from WWTPs owned by Brisbane Water and the scheme would not require changes to legislation. A permit trading scheme, involving all fourteen point sources, would provide the opportunity for greater benefits from trade, but would also require greater administrative effort for scheme setup and operation. The inclusion of offsets under either scheme would provide a means to engage diffuse sources in a voluntary way. It will also provide extra flexibility to market participants.

5.4.1 Illustrative nutrient load targets

In order to examine likely trading patterns and potential benefits, target nutrient loads to be achieved under the pilot need to be set. Each of the three options could be used to meet a range of load reduction targets. A specific load target has not been set for the investigation of the pilot trading scheme. For the purpose of this assessment, illustrative targets have been developed. We have examined the likely cost savings from trade, under either a Bubble or permit trading scheme, to meet the following targets by 2026:

- Capping total nitrogen loads from point sources in the Bramble Bay Bubble or permit trading cluster to the sum of:
 - individual WWTP 2009 load limit levels or, where there is no load limit, 2003-04 discharge levels, and
 - 2003-04 discharge levels at non-WWTPs.
- Capping total phosphorus loads from point sources in the Bramble Bay Bubble or permit trading cluster to 20 percent less than the sum of:
 - individual WWTP 2009 load limit levels or, where there is no load limit, 2003-04 discharge levels, and
 - 2003-04 discharge levels at non-WWTPs.

- Allocating nitrogen and phosphorous permits under the permit trading scheme equivalent to each sources individual contribution to the aggregate load limits described above; and
- Requiring any new Brisbane Water WWTP in the Bramble Bay cluster region to lead to no net change in the nitrogen and phosphorous targets under the Bubble as described above; or,
- Requiring any new point source licensed by the EPA in the Bramble Bay cluster region to lead to no net change in the nitrogen and phosphorous targets under the Permit trading scheme as described above, through buying existing permits equivalent to their nutrient discharges.

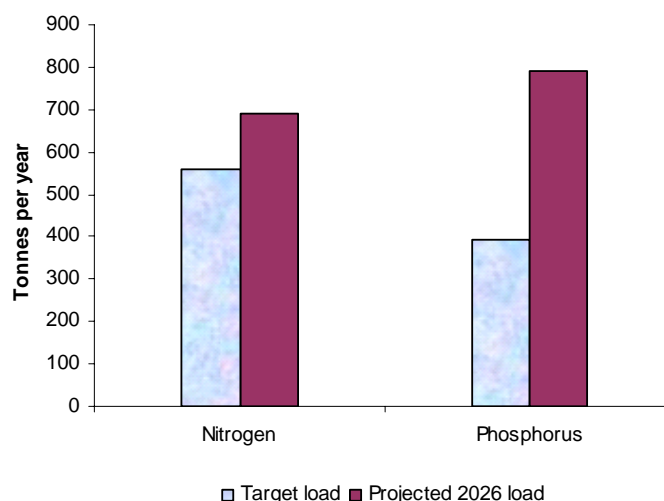
The Bubble load cap or available permits for nitrogen and phosphorus under these schemes would require the point sources to either reduce loads themselves or use trading to accommodate their loads in the face of population growth and development in the Bramble Bay area that will increase flows into the plants in the future.

5.4.2 Trade benefits from a Bubble scheme

Given the mix of point sources in the Bramble Bay cluster, a Bubble trading scheme could be established which incorporated the Brisbane Water WWTPs – Luggage Point, Oxley Creek, Gibson Island, Wynnum, Sandgate, Nudgee and Fairfield.

In accordance with the targets proposed above, this would translate into a nitrogen target for the Bubble of 559 tonnes per year. Figure 20 compares the nutrient targets with projected loads for the bubble trading scheme.

Figure 20: Comparison between nutrient targets under bubble trading scheme and projected 2026 loads



Based on BAU forecasts, to maintain compliance against this target would require action to abate an additional 130 tonnes of nitrogen per year expected by 2026 (over and above the

1,098 tonne per year reduction that will come from current upgrades at Oxley Creek, Sandgate and Wynnum WWTPs).

In the case of phosphorus, the target would equate to 395 tonnes per year. Based on BAU forecasts, to maintain compliance against the phosphorous target would require action to abate an additional 395 tonnes of phosphorus per year expected by 2026 (over and above the 20 tonne per year reduction in phosphorus that will come from current upgrades focusing on nitrogen at Sandgate and Wynnum WWTPs).

Overall, the illustrative load targets for the Bubble would lead to a 9 percent and 44 percent reduction in business as usual loads of nitrogen and phosphorus to Moreton Bay from these sources by 2016, and a 19 percent and 50 percent reduction respectively by 2026.

The cost curves shown in section 5.3 and discussed further in Appendix 3 have been applied to the Brisbane Water WWTPs in Moreton Bay to provide an indication of the relative cost-effectiveness of reducing nutrients at the various plants below.

Relative costs of reducing nitrogen loads

Most Brisbane Water plants currently achieve a nitrogen concentration of around 5 mg/L (or will achieve this on completion of current upgrades). Table 24 below provides preliminary estimates of the costs of using tertiary filtration to reduce nitrogen levels to around 2 mg/L. It should be noted that alternative options, such as effluent reuse may reduce loads at a lower cost. However, there are no costings available for reuse (apart from a proposal for Fairfield WWTP discussed separately below).

Table 24: Cost of reducing nitrogen to 2 mg/L at Brisbane Water plants

WWTP	Total cost over 20 years (\$m)	Annual load reduction (t/yr)	Cost effectiveness (\$/t/yr)
Luggage point	\$33	176	\$188,000
Oxley Creek	\$18	61	\$288,000
Sandgate	\$10	23	\$448,000
Wynnum	\$8	9	\$857,000
Gibson Island	\$16	18	\$858,000

Notes: Estimates assume current N levels as the starting point, except for Oxley Creek, Wynnum and Sandgate where starting N levels are assumed to be 5 mg/L expected once upgrades are complete.

The total cost over 20 years is the capital cost plus present value of annual operating costs over 20 years. Figures have been rounded for presentation in the table.

Separate costings for reducing nitrogen at the Fairfield WWTP have recently been developed by Brisbane Water, as a 24 tonne per year reduction is required below current loads in order to meet its annual limit for 2008. Table 25 below shows the costs of two options to meet the licence limit.

Table 25: Cost of meeting 2008 annual licence load limits for nitrogen at Fairfield WWTP

Option	Total cost (\$m)	Cost effectiveness (\$/t/yr)
Reuse	\$5	\$200,000
Upgrade to tertiary treatment	\$15	\$580,000

Based on the preliminary costings, reducing nitrogen is expected to be most cost-effective at Luggage Point (primarily due to scale) and Fairfield (due to the very high current concentration and feasibility of reuse).

Relative costs of reducing phosphorus loads

Most Brisbane Water plants currently achieve a phosphorus concentration of around 6-7 mg/L (or will achieve this on completion of current upgrades). Table 26 provides preliminary estimates of introducing metal salt dosing at the plants to reduce phosphorus down to around 2 mg/L.

Table 26: Cost of reducing phosphorus to 2 mg/L at Brisbane Water plants

WWTP	Total cost over 20 years (\$m)	Annual load reduction (t/yr)	Cost effectiveness (\$/t/yr)
Sandgate	\$1	39	\$38,000
Luggage point	\$9	214	\$40,000
Wynnum	\$1	15	\$43,000
Oxley Creek	\$4	71	\$52,000
Gibson Island	\$3	50	\$62,000
Fairfield	\$0.3	4	\$80,000

Notes: Estimates assume current P levels as the starting point, except for Wynnum and Sandgate where starting P levels are assumed to be 7 mg/L expected once upgrades are complete.

The total cost over 20 years is the capital cost plus present value of annual operating costs over 20 years. Figures have been rounded for presentation in the table.

Based on the preliminary costings, reducing phosphorus using metal salt dosing is expected to be most cost-effective at Sandgate, Luggage Point and Wynnum.

Reducing phosphorus to a lower level of around 0.5 mg/L through lime dosing is another option for the plants. Table 27 shows the costs and cost-effectiveness of this treatment option for various Brisbane Water plants.

Table 27: Cost of reducing phosphorus to 0.5 mg/L at Brisbane Water plants

WWTP	Total cost over 20 years (\$m)	Annual load reduction (t/yr)	Cost effectiveness (\$/t/yr)
Luggage point	\$23	286	\$82,000
Oxley Creek	\$12	102	\$121,000
Sandgate	\$7	50	\$146,000
Gibson Island	\$11	75	\$146,000
Wynnum	\$5	20	\$277,000
Fairfield	\$5	8	\$602,000

Notes: Estimates assume current P levels as the starting point, except for Wynnum and Sandgate where starting P levels are assumed to be 7 mg/L expected once upgrades are complete.

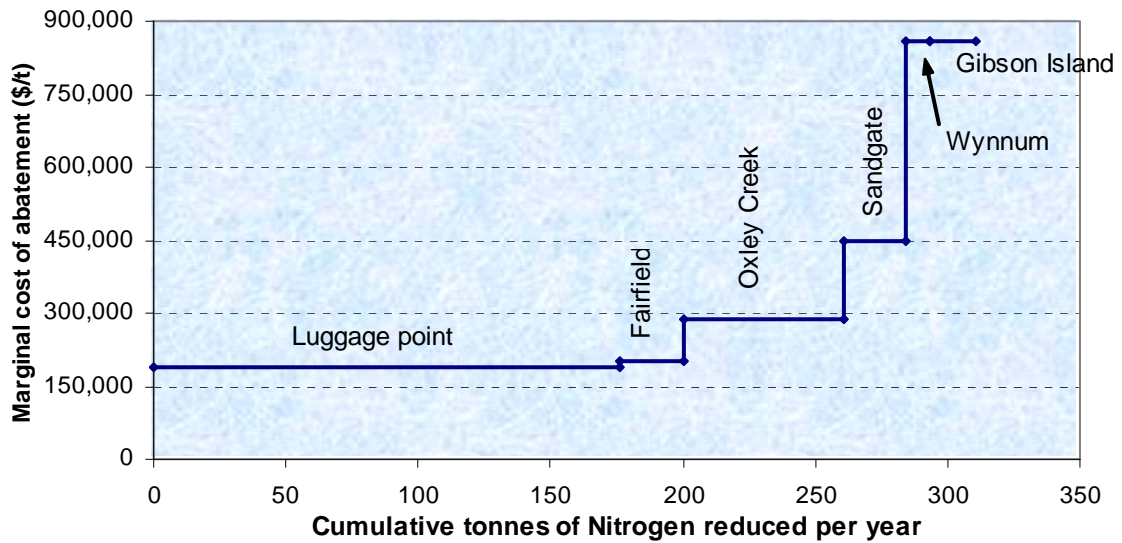
Lime dosing to reduce phosphorus would be most cost-effective at Luggage Point due to the scale of the plant.

Likely abatement patterns under bubble licence

The total reduction in nitrogen needed to achieve the indicative bubble target is 130 tonnes per year by 2026. Figure 21 shows how the marginal cost of abating nitrogen increases as a greater load of nitrogen is abated. The figure shows the cost of the cheapest abatement option for each plant for which cost data is available (reuse for Fairfield and tertiary filtration for all other plants). Reuse and other alternatives may be possible at some other plants, however the figure provides an indication of the likely relativities of costs between plants based on available information.

Nitrogen abatement through filtration at Luggage Point offers the cheapest way to reduce nitrogen on a per tonne basis. As this abatement would exceed the indicative target reduction of 130 tonnes per year all other plants could continue with current treatment processes under a bubble. The cost estimates suggest that if a reduction of greater than around 175 tonnes per year was required (under an alternative target), then reductions at other plants would be needed and the next best option would be reuse at Fairfield. An upgrade at Luggage Point alone would cost around \$33 million.

Figure 21: Nitrogen abatement costs under bubble

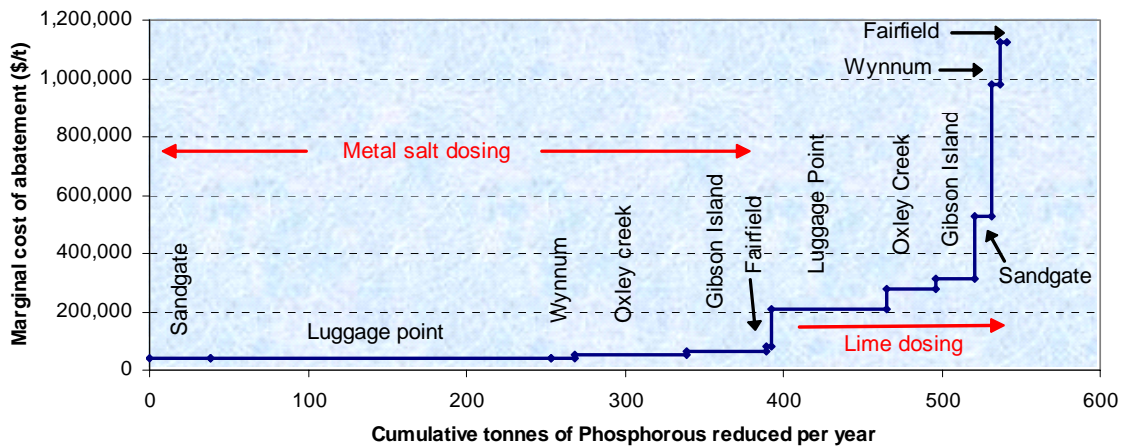


Under a traditional regulatory approach all WWTPs would be required to reduce nitrogen to achieve their individual targets (except Gibson Island as their load limit increases in 2008). Assuming this required tertiary filtration at all other plants the total cost would be around \$84m. Therefore under a bubble licence with the indicative target reduction of 130 tonnes per year, the bubble would save around \$51m. The reuse option at Fairfield has been estimated to provide a reduction of 24 tonnes. If reuse could provide the 29 tonne reduction required to meet Fairfield’s individual limit in the face of growth in loads, then tertiary filtration as well would not be required and the total cost of the traditional regulatory approach would be reduced by around \$10 million, as would the cost savings from the bubble.

The actual reduction achieved would be around 175 tonnes of nitrogen per year. However because of the stepped nature of the capital investments required for abatement at the WWTPs, the most cost-effective strategy to meet the illustrative bubble target would result in an additional 45 tonnes of nitrogen being abated.

The total reduction in phosphorus needed to achieve the indicative bubble target is 395 tonnes per year by 2026. Figure 22 shows how the marginal cost of abating phosphorus through metal salt dosing and lime dosing increases as a greater load of nitrogen is abated. Notably, the marginal cost of achieving additional abatement at any WWTP through lime dosing, over and above that which can be achieved through metal salt dosing, is greater than that shown in Table 27 as the cost difference between lime and metal salt dosing is attributed only to the marginal reduction in phosphorous loads achieved. Again it should be noted that there are a range of other options for reducing phosphorus (such as reuse) and the figure provides an indication of the likely relativities of costs between plants with the cost information available.

Figure 22: Phosphorus abatement costs under bubble



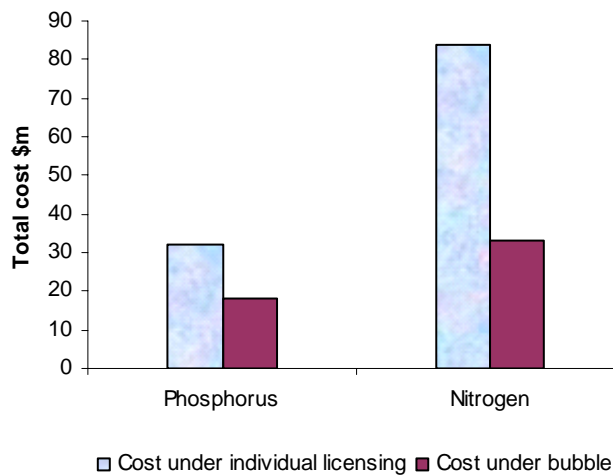
The indicative 20 percent phosphorus target of 395 tonnes reduced per year falls right near the point on Figure 22 where the switch in technology is required to achieve greater phosphorus reductions. Therefore to meet this target it is likely that all plants would be upgraded to using metal salt dosing to reduce phosphorus to 2 mg/L, with no optimisation of abatement required between plants. The total cost would be around \$18m.

If the 395 tonnes per year was to be achieved under the traditional regulatory approach all plants would be required to meet the 20 percent reduction in 2009 phosphorus limit levels individually. To meet this requirement all plants would need to introduce an abatement option like metal salt dosing and Sandgate and Oxley Creek WWTPs would need to go further. For Oxley Creek and Sandgate, their 2009 load limits have been set to reflect a concentration of 2 mg/L and therefore meeting a 20 percent of this level would require an option like lime dosing. The total cost to meet the reductions at all plants would therefore be at least \$32m, indicating a saving under the bubble of around \$14m.¹⁴

Figure 23 summarises the estimated costs of meeting the indicative phosphorus and nitrogen targets under individual licensing compared to a bubble licence.

¹⁴ As an example of how abatement might change with another target, if a 10 percent reduction in phosphorus levels was sought, then around 200 tonnes would need to be reduced. Figure 22 shows this could be achieved with the two cheapest per tonne abatement options at Sandgate and Luggage point. However, similar to the nitrogen example, an upgrade at Luggage Point would provide the entire reduction and would be the best option given that significant capital investments are required. Under this example, the total cost under traditional regulation would be \$18m (as Oxley Creek and Sandgate would only need to go to 2 mg/L) and the cost under the bubble would be \$9m, saving around \$9m.

Figure 23: Estimated costs of meeting indicative targets



In total, and based on our illustrative nutrient reduction targets, compliance cost savings from the Bubble scheme relative to traditional regulatory responses could be around \$65m, whilst also delivering an additional 45 tonne reduction in nitrogen loads. This equates to an additional benefit of \$8.5m, based on the marginal abatement cost of this additional nutrient reduction.

It should be noted that this simplistic assessment treats the reduction of nitrogen and phosphorus separately. There are treatment approaches that will reduce both nutrients. The assessment therefore overestimates the cost of reducing each, however the relativities between the cheapest and most expensive upgrades would remain.

Another limitation of the assessment is that it assumes all WWTPs have an environmental equivalence of 1:1. It is likely that the WWTPs higher in the catchment such as Oxley Creek and Fairfield would have less than a 1:1 equivalence with the other WWTPs further down as they are likely to have a lower per tonne impact on Moreton Bay. The environmental impact of discharges from Wynnum WWTP may also be lower because of the location of the discharge into Moreton Bay.

By way of illustration, if equivalency for Oxley Creek, Fairfield and Wynnum WWTPs relative to the others set at 1:2, it is estimated that the benefit of achieving phosphorous reductions under a bubble scheme relative to traditional regulation may fall by about half (see Appendix 4).

5.4.3 Trade benefits from a Permit trading scheme

This section considers the benefits of expanding trading beyond the Bubble to include other licensed sources in the Bramble Bay area.

Outside of the Brisbane Water WWTPs considered in the Bubble scheme, a permit trading scheme in the Bramble Bay cluster could include an extra three WWTPs (Redcliff, Murrumba Downs and Brendale who collectively discharge 66 tonnes of nitrogen and 36 tonnes phosphorous annually), and another four non-WWTP point sources (BP, Caltex, Incitec and Amcor who collectively discharge another 51 tonnes of nitrogen and 2.2 tonnes of phosphorous

annually). Collectively, these sources generate 19 percent of nitrogen and 6 percent of phosphorus loads from point sources in the cluster.

In accordance with the illustrative load targets proposed above, this would translate into a nitrogen target for the permit trading scheme of 676 tonnes per year. Based on BAU forecasts, to maintain compliance against this target would require action to abate an additional 150 tonnes of nitrogen per year expected by 2026 (over and above the 1,098 tonne per year reduction that will come from current upgrades at Oxley Creek, Sandgate and Wynnum WWTPs).

In the case of phosphorus, the target would equate to 426 tonnes per year. Based on BAU forecasts, to maintain compliance against the phosphorous target would require action to abate an additional 416 tonnes of phosphorus per year expected by 2026 (over and above the 20 tonne per year reduction in phosphorus that will come from current upgrades focusing on nitrogen at Sandgate and Wynnum WWTPs).

Overall, the illustrative load targets for the permit trading scheme would lead to a 7 percent and 41 percent reduction in business as usual loads of nitrogen and phosphorus to Moreton Bay from these sources by 2016, and an 18 percent and 49 percent reduction respectively by 2026.

Trade in nitrogen reduction permits

Fairfield would be the only Brisbane Water plant with an urgent requirement to reduce nitrogen. However, the cheapest option for Brisbane Water is abatement at Luggage Point and this would be required in the longer term to ensure Luggage Point stays within its permit holding as inflows increase over time. Given the significant load reduction that would come from an upgrade of this large plant, Brisbane Water are likely to bring forward this investment at Luggage Point and sell surplus nitrogen permits to the other Brisbane Water WWTPs of Fairfield, Oxley Creek, Sandgate and Wynnum.

The non-Brisbane Water WWTPs would also all be possible buyers of nitrogen permits once growth in volumes increased loads beyond current levels. Under a traditional regulatory approach if they were required to upgrade treatment levels to keep within their nitrogen load limits the total cost of this for the three plants could be around \$26m (based on the cost relationships discussed in Appendix 3). However, there may be other options to reduce nitrogen from these plants.

In the case of the non-WWTP point sources, assumed nitrogen permit allocations would mean they would not have permits to sell. They would only need to abate or buy permits if their level of activity and therefore nitrogen discharges increased over time. This analysis assumes their emissions do not change and they do not participate in trading.

Based on current information available, including the three non-Brisbane Water WWTPs in a permit trading scheme is unlikely to change the sources of nutrient abatement among Bubble WWTPs. That is, Luggage Point is still likely to abate nitrogen and sell permits to the other

sources. The scheme could provide some additional benefits compared with a bubble by avoiding the need for improvements at the non-Brisbane Water plants.

However due to the estimated “over-compliance” under the bubble of some 45 tonnes, the environmental outcomes would be the same, with the estimated cost-savings under the permit trading scheme inflated by the estimated value of the bubble over-compliance. If the relative trade benefits are adjusted to reflect this, the benefits from nitrogen abatement under the permit trading scheme relative to the bubble is reduced to around \$18m.

Trade in phosphorus reduction permits

For phosphorus, the greatest reductions required from Brisbane Water plants over time to meet permit holdings would be at Luggage Point and Oxley Creek. All WWTPs would either need to undertake abatement action or purchase permits to meet their permit allocations.

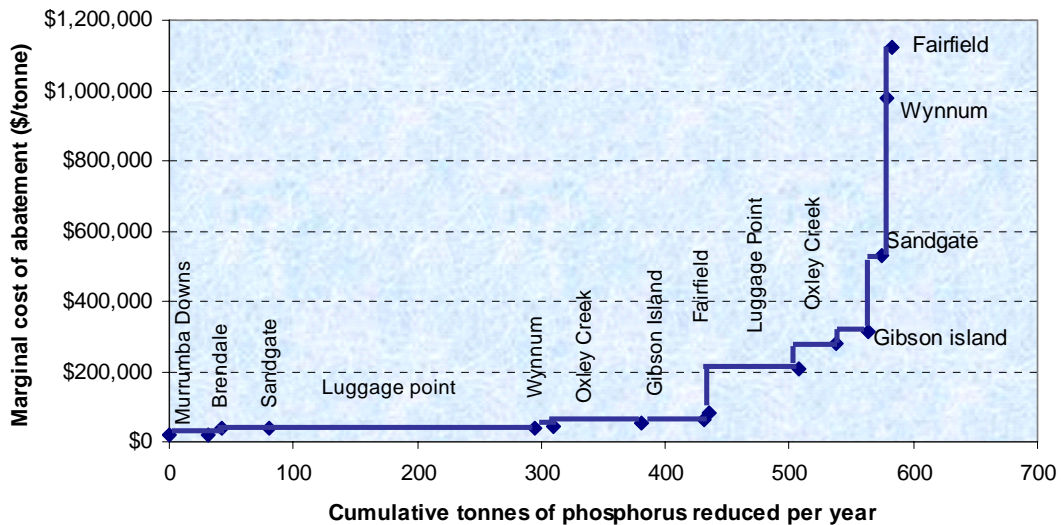
Murrumba Downs and Brendale both need to meet current concentration limits for phosphorus. Pine Rivers Shire Council has estimated the capital costs of chemical dosing to reduce phosphorus levels at Murrumba Downs and Brendale (to meet their current EIP) is \$600,000 and \$400,000 respectively. This would bring phosphorus levels down to 1 mg/L reducing loads by 31,000 and 11,000 respectively. The cost per tonne would be around \$19,000 and \$36,000 respectively. Based on these costs it is likely that it would be cheapest for Murrumba Downs and Brendale to reduce phosphorus loads on site to meet permit conditions and sell excess permits.

While Redcliff does not have a load limit for phosphorus, it is assumed that permits would be allocated based on 2003-04 loads, and incorporate a phosphorus reduction of 20 percent. Redcliffe would therefore be a possible buyer of phosphorus permits, particularly given its current low phosphorus levels in effluent. There is no cost information available for phosphorus reduction at Redcliffe. If the cost relationships discussed in Appendix 3 are applied, phosphorus abatement at Redcliffe could cost around \$5m per tonne.

In the case of the non-WWTP point sources, these sources would need to either reduce their phosphorus discharges or become permit buyers as their permit allocations for phosphorus would be constraining (set at 20 percent below current levels under the illustrative targets proposed for the scheme). However, their current phosphorus loads are very small (1 tonne or less annually) and so such trades would provide small benefits relative to other trading.

Figure 24 shows phosphorus abatement costs for all players in the permit trading market where cost data is available.

Figure 24: Phosphorus abatement costs under permit trading



Note: the figure excludes the estimated costs for Redcliffe, it is the last point on the curve at \$5m per tonne

The most likely trading pattern is very similar to the bubble licence. The initial level of phosphorus abatement would be undertaken at the same WWTPs – except Murrumba Downs and Brendale would abate instead of Fairfield WWTP. This would provide the total phosphorus reduction required. Based on current information, Oxley Creek and Sandgate are likely to abate phosphorus on site and then buy the extra phosphorus permits required from the other WWTPs in order to meet their permit conditions. The total costs of meeting the phosphorus target under permit trading would be around \$18m, very similar to the costs under the bubble. If a traditional regulatory approach was applied to the wider set of participants to meet the targets, Murrumba Downs and Brendale WWTPs would also need to reduce phosphorus at a total cost of around \$1m. Redcliffe WWTP would also need to reduce phosphorus under a traditional regulatory approach, however, there is less certainty around the likely costs of this reduction. Preliminary estimates suggest it could be in the order of \$5m.

There is inadequate information available at this stage to assess the impact of including the non-WWTP sources, but the only discharge that could have a demonstrable impact is in relation to nitrogen loads from Incitec.

5.4.4 Trade benefits from including offsets with bubble licence or permit trading

This section examines the possible benefits of including offsets as part of either the bubble licence scheme or permit trading scheme discussed above.

The inclusion of voluntary offsets as a means for liable parties to meet compliance targets under either a bubble or permit trading structure offers the potential to further reduce costs. As found in other states, diffuse source, often rural-based, offsets can provide a low-cost means to reduce nutrient loads to waterways.

Currently we do not have robust data on the likely magnitude of such nutrient reduction opportunities. Nevertheless, some considerations are worth noting.

Firstly, for markets to operate efficiently they need liquidity. Given that there are significant capital costs associated with nutrient abatement from the point sources, offsets may be used effectively to achieve nutrient reductions which are small in magnitude but nonetheless useful for meeting a particular quantitative target. For example, under the bubble implementing metal salt dosing at all plants was proposed earlier in this section as a strategy to meet the phosphorus target of 395 tonnes per year. However the estimates suggest it may fall short by 2 tonnes per year. Offsets could be used to pick up the extra reductions, thereby avoiding the need for the next major investment. In this way, offsets could add liquidity to either a bubble or permit trading market and also provide opportunities for risk management.

Secondly, offset sources face no regulatory requirement. Any nutrient reductions and their accreditation as offsets would be voluntary, and presumably only sought where the owner believed the offsets would be cost-effective relative to nutrient reduction opportunities possible at the regulated point sources. This means that any offsets will serve to increase trade benefits as long as transaction costs are low. Transaction costs will include those involved in estimating load reductions, gaining accreditation and developing any trading ratios.

Thirdly, trading ratios are unlikely to significantly work against offsets as the Bramble Bay cluster has been spatially defined to minimise differences in the environmental equivalence of alternative nutrient sources.

Fourthly, the point sources included in a permit trading scheme but not in the bubble scheme, could be included as voluntary offsets under a bubble scheme. Therefore any potential low cost non-Brisbane Water WWTP source of nutrient abatement could still be captured, reducing the already small trade benefits of a permit trading structure over a bubble structure.

5.4.5 Summary of outcomes and resources required

Table 28 summarises the load reductions and possible level of benefits from trade from using the bubble and permit trading approaches to meet the illustrative targets.

Table 28: Summary of nutrient abatement compliance cost savings to meet illustrative targets

	Bubble	Permit trading
Nitrogen	\$51m	\$69m
Phosphorous	\$14m	\$20m
<i>Total</i>	<i>\$65m</i>	<i>\$89m</i>

Setting up a bubble licence may require a dedicated project manager for 6 months to develop draft targets, undertake negotiations with Brisbane Water and broader consultation, to address environmental equivalence issues and develop the bubble licence conditions. The project manager would also need the assistance of the science, policy licensing staff within the EPA. The total resources required could be around 0.75 full time equivalent (FTE) persons at a total cost of \$80,000 (including on-costs). The ongoing costs of the bubble licence would not be any different to enforcing other licence conditions, and in the absence of the bubble, administrative effort for licensing would still be required. There may be some extra ongoing costs associated with reviewing the bubble licence once the bubble targets are met.

Setting up a permit trading scheme would require greater setup resources, particularly for the process of permit allocation among the different entities and addressing equivalence issues covering different types of licensed sources. As indicated earlier, the United States Environmental Protection Agency spent some \$44m over 5 years establishing the acid rain scheme in the US, including direct staffing of around 50 FTE during its 18 month development, 35 FTE during a two year implementation phase and 12 FTE on an ongoing basis. The operation of the Hunter River Salinity point source trading scheme in NSW costs around \$0.5m per year. However most of this cost relates to real time monitoring that would not be required for the nutrient trading scheme. The total resources required to setup the scheme for Bramble Bay may be around 2 FTE over 18 months at around \$240,000 including on costs. The ongoing operational management costs would also be much greater than for the bubble licence as it would involve approval of trades over time. The ongoing management is likely to involve 1 FTE on a permanent basis at a cost of around \$100,000.

The inclusion of offsets would increase the resources required for scheme development and ongoing administration. There would be some initial resources required to set up the arrangements for approving and recognising offsets under the licensing system for either the bubble or permit trading scheme. Resources for establishing trading ratios for offsets would be an ongoing requirement under both schemes with ratios set on a case by case basis. The extra

ongoing costs include the costs of reviewing and approving offset proposals and plans and auditing and enforcement functions. The costs would be greater under permit trading as there would be a greater number of entities potentially arranging offsets. The actual level of ongoing costs would depend on the opportunities for offsets.

5.5 Bubble licence with offsets trading structure recommended

The Bubble with offsets approach would provide demonstrable environmental gains as measured by nutrient load reductions. The suggested sources for inclusion in the Bubble represent 25 percent of current nitrogen and 40 percent of current phosphorus loads to Moreton Bay. The suggested load targets in Section 5.4 would, by way of example, lead to a 19 percent and 50 percent reduction in business as usual loads of nitrogen and phosphorus to Moreton Bay from these sources by 2026. Moreover, the scheme could provide compliance cost savings in the order of \$65m – an approximate halving in necessary expenditures.

The permit trading option could provide an increase of up to \$24m in compliance cost savings. However available data on the likely compliance costs for the non-Brisbane Water WWTPs is less robust, and caution is needed with respect to the extent of additional cost savings from a permit trading scheme relative to the bubble scheme. Of more certainty however is that there would be greater resources required for a permit scheme development, administration and operation.

The Bubble with offsets approach would provide the greatest likelihood of success, both from a design perspective and likely willingness of Brisbane Water to cooperate in a scheme directed at reducing its compliance costs. Under a permit trading scheme, a key participant concern is the means of permit allocation and how they will fare relative to other sources. This problem is avoided with the suggested Bubble approach as all sources are under common ownership; load limits reflect recently negotiated positions with the EPA and are consistent with longer term nutrient reduction goals for Moreton Bay.

The inclusion of offsets provides an important opportunity to engage diffuse sources in a voluntary way and maximise the learning to be gained from the pilot. It will also provide extra flexibility to Brisbane Water and help to foster a cultural change away from end-of-pipe solutions. The proposal also sits well as a first step in an evolution towards more expansive schemes. Indeed the proposed pilot would start with a similar trading structure to that which has taken some 8-10 years to emerge in South Creek NSW. Upon the early success of the Bramble Bay Bubble Licence Nutrient Trading Pilot, it could be expanded to include the three non-Brisbane Water WWTPs if subsequent investigations confirmed the potential compliance cost savings that doing so could offer.

6. POLICY FRAMEWORK AND DESIGN PRINCIPLES

The purpose of this section is to canvass key design issues for a Bramble Bay Bubble Licence Nutrient Trading Pilot that will need to be addressed in Phase 2 of the CCI Moreton Bay study. The section presents a broad framework consistent with:

- The identified strategic, economic and environmental context
- The recommended pilot area (Bramble Bay) and trading instrument (Bubble Licence Nutrient Trading Pilot).

6.1 Scheme principles

A recent set of trading principles were established for the Pollution Reduction Trading Scheme for South Creek in NSW. The scheme includes a provision for diffuse offsets to meet current or future load limits at EPA licensed sources. The relevant principles are:

- All standard regulatory requirements must still be met.
- The scheme must not reward poor environmental performance.
- The scheme will complement other government programs.
- The scheme aims to achieve a net environmental improvement.

The US EPA's 2003 Water Quality Trading Policy Statement identifies a number of common elements of credible trading programs which are also relevant for a Moreton Bay Bubble Licence Nutrient Trading Pilot. These are:

- Clear legal authority and mechanisms for trade
- Clearly defined units of trade
- Corresponding creation and duration of credits
- Ensuring uncertainty is managed, for example, through monitoring, trading ratios, conservation assumptions regarding effectiveness of measures, using site-specific discount factors or retiring a proportion credits.
- Compliance and enforcement provisions using a combination of record keeping, monitoring, reporting and inspections
- Public participation and access to information
- Program evaluations

Key principles recommended for a Bramble Bay Bubble Licence Nutrient Trading Pilot are:

- I. Nutrient trading must result in an equivalent or better water quality outcome to trading parties. - to ensure this outcome, trades must be based on ratios that account for environmental equivalence, risk and uncertainty and the EPA must ensure appropriate compliance and enforcement provisions.
- II. All standard regulatory requirements must still be met.
- III. Minimum standards for offset providers will be used to ensure the scheme does not reward poor environmental performance.
- IV. All parties will be kept accountable and informed to make sure nutrient trading achieves its objectives.
- V. Nutrient trading should not be approved if it may lead to another negative environmental outcome.
- VI. The Pilot will be evaluated, with public participation, after 5 years.

6.2 Legislative basis

The existing Environmental Protection Act 1994 could be the legislative basis for the Bramble Bay Bubble Licence Nutrient Trading Pilot. New load limits for nitrogen and phosphorous discharges, and any reduction requirements, would need to be established for the seven Brisbane Water WWTPs proposed to be included in the bubble licence.

The EPA has issued Brisbane Water with licences for these WWTPs as environmentally relevant activities in accordance with section 93 of the Act. The new load limits could be established as new overall licence conditions for the combined licences or as new discharge limits in the Environmental Protection Regulation 1998. Setting new licence conditions would be simpler and could be adequate for a pilot bubble licence, however, given that it is proposed to allow offsets and depending on the significance of the nutrient reductions, a formal amendment to the Environmental Protection Regulation 1998 may be considered more appropriate. A regulatory framework for nutrient trading to achieve the new nutrient requirements could also be established in the Environmental Protection Regulation 1998. Either way, administrative implementation would occur through the current licensing system.

A regulatory provision may be needed in the Environmental Protection Regulation 1998 to allow "offset credits" issued by the EPA to contribute towards meeting load limits. The provision would set out the circumstances under which the EPA could issue an offset credit to a licensee and how offsets could be used to meet license compliance. The EPA is currently formalising an offsets policy (for specific issues in relation to using offsets to meet both licence requirements and conditions of environmental authority) and any new regulatory provisions would need to be consistent with that policy.

Failure of Brisbane Water to meet licence limits for nutrient discharges, through either on-site management action or offsets, would lead to a breach in licence conditions with existing penalty provisions applying.

The new regulatory provisions could also include formal evaluation of the pilot program, with public participation, after 5 years. Establishing a regulatory framework for nutrient trading in the Environmental Protection Regulation 1998 would provide a basis for the evolution of the pilot into a permanent and/or expanded scheme in future.

6.3 Establishing aggregate nutrient load limits

There would be one liable party in the Bramble Bay Bubble Licence Nutrient Trading Pilot - Brisbane Water. Brisbane Water would have an obligation to meet new aggregate load limits for nitrogen and phosphorus discharges from its seven WWTPs in the Bramble Bay area. The limits could be established with transitional arrangements, for example declining over a set number of years.

The EPA is already moving towards greater use of loads in licence requirements. In order to implement the Bramble Bay Bubble Licence Nutrient Trading Pilot, the WWTPs to be included in the scheme will need to have aggregate load limits that are *constraining*. Table 29 shows whether the seven WWTPs proposed to be included currently have nutrient load limits.

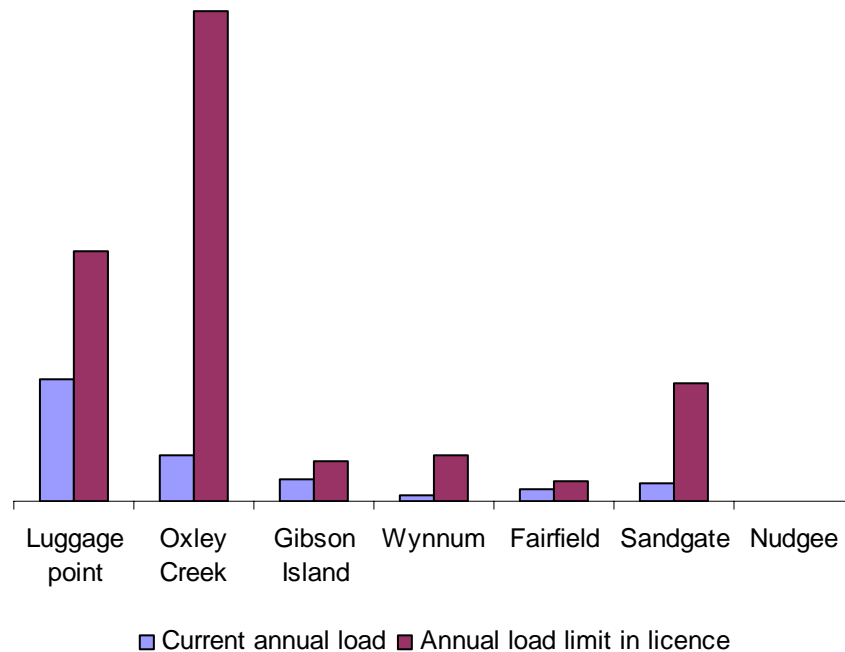
Table 29: Load limits in Brisbane Water WWTP licences in Bramble Bay cluster

Licensee	Load limit for nitrogen?	Load limit for phosphorus?
Sandgate	Yes	By 2009
Nudgee	Yes	No
Luggage Point	Yes	No
Gibson Island	Yes	No
Fairfield	Yes	No
Oxley Creek	Yes	By 2009
Wynnum	Yes	No

Source: EPA licensing database, June 2005

All licensees currently have an annual load limit for total nitrogen. None of them currently have a load limit for phosphorus. As shown in Figure 25 below, none of the nitrogen limits are currently constraining (as EPA has primarily been using concentration limits to control discharges).

Figure 25: Comparison of current nitrogen loads and load limits in licences



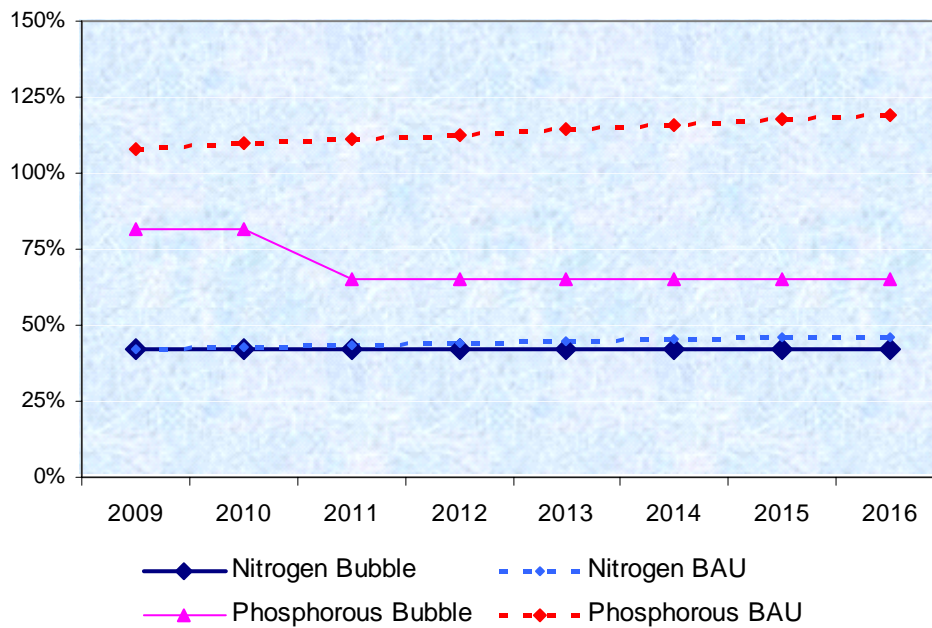
Under a Bubble Licence, Brisbane Water would have new aggregate nutrient load limits for these WWTPs and would have flexibility to meet them by optimising nutrient abatement effort (through upgrades of treatment technology or effluent reuse) amongst the seven plants as well as using offset credits (discussed further below).

The Bramble Bay Bubble Licence Nutrient Trading Pilot could be set to achieve various nutrient targets. To illustrate the type of obligations that could be set under the pilot, the example of nutrient targets for 2026 used in the previous section are considered. In this case the bubble licence would be set to:

- Cap nitrogen loads from the seven WWTPs at 2009 licensed levels through to 2016;
- Cap phosphorus loads from the seven WWTPs at 2009 by their licensed level (as in the case of Sandgate and Oxley) or at a level equivalent to their 2003-04 discharge load;
- To reduce the 2009 phosphorus load cap by 20 percent by 2011 through to 2016; and
- Requiring discharges from any new Brisbane Water WWTP in the Bramble Bay cluster to be accommodated in the Bubble nitrogen and phosphorous targets as described above.

These illustrative nutrient load targets for the Bubble license, relative to BAU loads are shown in Figure 26.

Figure 26: Nutrient discharges under an illustrative Bubble and BAU (as % current)*



* The nitrogen BAU loads imply load limits are relaxed (as has been the case already with Gibson Island) to accommodate increasing wastewater inflows with ongoing population growth.

A single aggregate load limit could be set to apply from a certain date (as for nitrogen in the example above), or a series of declining limits could be set to encourage steady progress towards the end target (as was done for the South Creek bubble licence scheme). In the illustrative example shown, nitrogen loads are capped, and not reduced, to reflect the substantial gains that will be delivered from the current round of plant upgrades and dominance of diffuse source of nitrogen once WWTP upgrades are completed. Over time, further reductions could be sought consistent with the desired contribution from point sources to achieve targeted water quality goals.

It should also be noted that the capping of nitrogen loads at 2009 licence levels may also provide significant compliance cost savings associated with the current round of upgrades if the scheme were introduced in the near term.

If there are environmental equivalence issues between WWTPs in the group then the aggregate load limit may need to be specified in a different way – such as “Luggage Point” equivalent tonnes - and trading ratios established within the bubble licence. For example if Oxley Creek and Fairfield WWTPs were thought to have only half the impact on Moreton Bay as other WWTPs due to the location of their discharges, then their loads would be halved to estimate “Luggage Point” equivalent tonnes that would be counted in order to calculate compliance with the aggregate Bubble limit. A trading ratio would apply to any offset measures (from either point or diffuse sources) and these are discussed further below.

There may also be a need for some restrictions on the way the aggregate load limit is met in order to prevent hotspots. Hot spots occur where trading results in localised areas with high

levels of pollution (around sources where abatement is more expensive). This is a concern with any scheme that allows an increase in pollution load (for example from expansion of one WWTP) to be offset by another source.

6.4 Rules for offset creation

Offset credits could be created by any source discharging nutrients in the Bramble Bay area. This includes licensed or unlicensed sources. For example, offset credits could be created by other WWTPs, other licensed point sources (such as the refineries), urban development or diffuse agricultural sources.

Offset measures would need to meet certain criteria and be approved by the EPA. The South Creek pilot pollution reduction trading scheme provides an example of a set of requirements for offset measures. Under this scheme, offsets must be enduring, quantifiable, targeted, located appropriately and supplementary. Each of the characteristics is discussed below.

The requirement for offsets to be *enduring* is to ensure that the duration of the benefits from the offset matches the impact of the party purchasing the offset. In the context of Bramble Bay, it is important that the duration and timing of the offset measure is such that the offset provides at least an equal environmental outcome compared with on-site abatement by Brisbane Water. While the timing of discharges has been taken into account in determining environmental equivalence, it is important that the EPA is satisfied for each case that an equivalent outcome will be provided. Credits may be issued in perpetuity or may have a specified expiry date in accordance with the timing of the reduction from the nitrogen source. Banking and borrowing is common under some trading schemes, however it is not appropriate in the Bramble Bay context as compliance with the total nutrient target is necessary each year.

In most schemes there is a requirement that offsets are *quantifiable*. It is essential to be able to verify that the use of an offset by a licensee to meet a target provides an equivalent environmental outcome. In the context of Bramble Bay this means the nutrient reduction must be able to be reliably estimated. Where the cost of actually measuring nutrient pollution is prohibitive (for example for some diffuse sources), there must be acceptable estimation techniques, such as robust models or generation factors available, as well as satisfactory verification techniques.

The requirement in the South Creek pilot scheme that offset measures are *targeted* refers to a requirement that the offset measure must address the same pollutant as the original impact. In the Bramble Bay context this means that offset measures that reduce nitrogen can assist in complying with nitrogen limits, not phosphorous limits – and vice-versa.

All schemes have some sort of boundary within which offset measures can be *located*. For example, in the US Wetlands Banking Scheme, offsets must be within defined service areas of similar climate and ecosystem type. In the Bramble Bay situation, a boundary for potential offsets needs to be identified to guide investigations by interested parties. It may be prudent to indicate a more “expansive” boundary to maximize offset opportunities, as long as information

on caution is provided that such offsets may attract higher trading ratios and in some instances may not be accredited where equivalence cannot be determined.

The requirement for offsets to be *supplementary* is essential to ensure any scheme does not reward poor environmental performance. The Sydney Drinking Water Catchment Offset scheme requires that “*an offset proposal cannot include pollution abatement measures if they are already required under federal, state or council legislation, or any other requirements, or if Government funds them. This includes measures required by an environment protection licence condition (including pollution reduction programs). Credit will not be given for work that would have happened anyway (e.g. decommissioning a plant that was already scheduled for closure)*”.

In the context of Bramble Bay, offset measures must be beyond current regulatory requirements, including any licence conditions, environmental management program, provisions of the Environmental Protection (Water) Policy 1997, or requirements under environment or planning legislation or approvals processes. In addition, they should not already be credited or funded under another scheme such as through the Natural Heritage Trust or the National Action Plan for Salinity and Water Quality.

Box 1: Nutrient offsets in Bramble Bay must be:

Equivalent in duration/timing – the duration/timing of the nutrient reduction from the offset must be equivalent to that of the source.

Targeted – they must address the same pollutant as the original impact

Quantifiable – the nutrient reduction from the offset must be able to be reliably estimated.

Located appropriately – the measures must reduce a source of nutrients located within the Bramble Bay area and environmental equivalence can be established.

Supplementary – beyond current regulatory requirements and not credited or funded under another program

Box 1 summarises the characteristics of offsets required for approval in the Bramble Bay context.

6.5 Duty of care or minimum standard

Most trading or offset schemes set out a duty of care or minimum standard that offset providers must meet before they can participate in an offset or trading scheme. The duty of care may reflect a performance level better than required under legislation or government requirements, but reflects community expectations for environmental stewardship. By setting a duty of care, offset credits will not be issued for nutrient reduction activities that the community believes should already have been realised. The EPA could require a minimum level of nutrient

management by offset providers in the Bramble Bay area, from which additional abatement may be approved for offset purposes.

The USEPA has set baselines for pollution reduction credits in its 2003 Water Quality Trading Policy Statement. It recommends that the baseline for point sources is established by the applicable water quality based effluent limitation, a quantified performance standard or a management practice derived from water quality standards. The baseline for diffuse sources is recommended as the level of pollutants associated with existing land uses and management practices that comply with applicable regulations.

The Sydney Drinking Water Catchments offset scheme envisages a duty of care criterion for participating landholders. Landholders will be expected to demonstrate that they are meeting their statutory obligations and achieving at least minimum environmental standards before additional offsets can be located on their properties. Initially, the existence of an appropriate farm management plan may be taken as evidence that the landholder is meeting minimum environmental expectations.

In the Bramble Bay context, any licensed point source generating offset credits should be complying with current licence conditions. There may also be a case for requiring a licensed point source to reach a satisfactory level of environmental performance before providing offsets, if this is not currently reflected in licence conditions. For example, where an environmental management program is in place to improve performance this may need to be completed before offsets can be provided.

If the point source is not licensed, the minimum requirement could be developed drawing on the provisions in the Environmental Protection (Water) Policy 1997. Alternatively, separate minimum or benchmark levels of performance for particular activities could be established as a pre-requisite for creating offsets. However, a balance would be required because setting a high benchmark may actually discourage participation and reduce the opportunities to achieve improvements under the scheme.

6.6 Trading ratios

Key ratios, such as between the Brisbane Water WWTPs, need to be established from the outset and embedded in the setting of the aggregate load limits for the bubble licence. The original Bramble Bay cluster (where environmental equivalence was considered likely to be 1:1) included four of the Brisbane Water WWTPs: Luggage Point, Gibson Island, Sandgate and Nudgee. There are some equivalence issues to be considered between these and the other three WWTPs: Wynnum, Fairfield and Oxley Creek.

Trading ratios between Brisbane Water and offset sources will be used to ensure that any trading provides an equivalent environmental outcome. Trading ratios should account for three main issues:

- Environmental equivalence – different impacts from different sources taking into account their location, chemical form and timing of discharge
- Uncertainty in estimating current loads of nitrogen, and load reductions from measures to reduce nitrogen discharges
- The risk that an offset measure underperforms

In section 3.3 the difficulties in establishing equivalence between point and diffuse sources in SEQ were discussed. The conclusion was that any trading mechanism involving diffuse sources should allow for assessment of equivalence on a case-by-case basis (rather than attempting to set-up a rules based system). Therefore, trading ratios for all offsets are proposed to be determined on a case-by-case basis to reflect differences in environmental equivalence, uncertainty with measurement and risks associated with offsets.

6.7 Trading arrangements

Trading within the Bubble would be an issue internal to Brisbane Water, with the EPA's interest restricted to ensuring overall compliance. Trading between Brisbane Water and other licensees should be undertaken on a bilateral basis under commercial arrangements between Brisbane Water and the offset providers. The EPA should however act to amend the load limits on the seller's license to reflect the transfer of discharge rights. No change in load limits is required on Brisbane Water's license, but the purchased permits would be counted towards assessing net discharges and license compliance with the aggregate load limits.

Some early offset schemes, including the wetland offsets in the US, focused primarily on offset initiation without adequate follow-up monitoring and offset failure was common. Monitoring and enforcement may be undertaken using a combination of record keeping, estimation, verification, monitoring, reporting and inspections.

Proposed estimation or monitoring techniques for offset measures need to be reviewed by the EPA before an offset is approved to ensure they are reliable and robust. If necessary, independent verification could be sought by an external expert.

Once the offset is approved, regular reporting should be required through the licensing system. Rigorous assessments of compliance with licence conditions will be needed where offset measures are contributing to compliance. This will include review of estimation/monitoring results, inspections at critical points and where necessary, independent verification of outcomes achieved.

Liable parties would be solely responsible for ensuring the performance of offsets and negotiating non-performance arrangements with offset providers. Where an offset fails to provide anticipated nutrient reductions, only realised reductions will be credited to the liable party holding the offset. The liable party will be responsible for ensuring alternative arrangements for compliance with licence conditions.

6.8 Scheme management and evolution

The EPA would be the scheme manager for the Bramble Bay Bubble Licence Nutrient Trading Pilot. There will be some setup costs to make the regulatory and administrative changes required to implement the bubble licence and provide for offsets under the current system. The ongoing costs of administering the scheme include the costs of reviewing and approving offset proposals and plans, auditing and enforcement functions. It is likely to require a dedicated project manager for one year to setup the initial pilot scheme. The actual level of ongoing costs would depend on the opportunities for offsets and how the scheme evolves over time.

There is also potential for the EPA and/or Brisbane Water to sponsor demonstration offsets at diffuse sources as part of the pilot scheme to gain greater experience in developing abatement techniques and estimating load reductions.

In section 5.2 it was noted that there had been an “evolution” of trading instruments in the US and Australia from opportunistic trading to more expansive permit trading schemes, and that this evolution had been critical to fostering a cultural change among stakeholders, developing the scientific and regulatory skills to support trading and in garnering political support. For these reasons, consideration of how nutrient trading in SEQ could evolve is pertinent to both the development of the Pilot scheme and associated activities that may pave the way for future reforms. The initial trading scheme will be characterised by;

- Trading “internal” to Brisbane Water using established trading ratios/rules;
- The likelihood that early offsets by Brisbane Water will focus on urban sources, principally stormwater under the control of Brisbane and Pine Rivers Councils, with trading ratios and compliance arrangements to be determined on a case-by-case basis with the EPA;
- Exploratory offsets with rural diffuse sources aimed at developing acceptable load estimation techniques, trading arrangements, monitoring and enforcement regimes, as well as to confirm the cost-effectiveness of these offsets; and
- Be a pilot, whose compliance, cost-effectiveness and regulatory efficiency will need to be reviewed along with its on-going integration with broader water quality goals and programs in SEQ ahead of proposals for changes to the Pilot scheme or its replication elsewhere.

Subject to the success of the Pilot Bubble Scheme, there are a number of potential steps in the further evolution of nutrient trading in SEQ. These are canvassed below.

6.8.1 Parallel nutrient bubble schemes

There are some 60 point sources licensed by the EPA (including 45 WWTPs) in the SEQ catchments investigated, with only 14 of them to be included in the proposed Bramble Bay Bubble. This raises the possibility of developing other bubble schemes. However of the three high feasibility catchments not involved in the Bramble Bay Bubble, only the Logan/Albert

offered a potential point to point trading opportunity. And even in the case of the Logan/Albert, the Loganholme WWTP dominated both nitrogen and phosphorus loads.

The most attractive opportunity for a second nutrient bubble scheme lies in the Maroochy/Mooloolah Rivers catchment. This catchment was not included among our high feasibility catchments as it does not discharge directly to Moreton Bay. However a reduction of around 49 percent of current nitrogen loads and 68 percent of phosphorus loads is thought necessary for the estuary and coastal waters adjacent to the catchment to meet water quality objectives in the draft 2004 Queensland Water Quality Guidelines. This is against a backdrop of point source loads of nutrients expected to increase by around 50 percent by 2026.

There are five WWTPs licensed by the EPA in the catchment, although at present they do not have load limits in their licences. There are significant and increasing nutrient loads from diffuse sources and active community organisations that would be supportive of reform opportunities. A bubble scheme could probably be established in the Maroochy/Mooloolah Rivers catchment with modest establishment costs as it would largely mirror the structure of the Bramble Bay Bubble.

To promote other bubble trading opportunities, early scoping should proceed in parallel with the detailed development and implementation of the Bramble Bay Bubble.

6.8.2 Development of "rules-based" offset trading and/or banking

To promote greater offset trading (with associated compliance savings) the transaction costs in establishing offsets need to be minimised. Experiences in the US and elsewhere have shown a reluctance to embrace offsets, especially diffuse source offsets, where trading ratios and associated load estimation, compliance and monitoring regimes are not endorsed in advance. Case-by-case negotiation of offset conditions also imposes significant costs on the regulatory body.

A move to "rules-based" trading can overcome these problems, if there is confidence in the environmental equivalence imbedded in trading rules (ratios) and sound procedures for ensuring the integrity of offsets and environmental improvements. Accordingly, the move to "rules-based" trading will require a program of research supported by lessons from the offsets developed under the initial Bubble scheme.

The EPA's sponsorship of offsets under the pilot bubble could also assist in an evolution to a central offset bank in future where participants can purchase credits. Such an offset bank could be administered by a third party (such as a Catchment Management Authority) and be self-funding through its trading activities. The success of offset banking would depend significantly on the volume of offset trading. In the proposed pilot scheme trading, activity would be modest, at least in the early years. Therefore the merits of offset banking could be included in the proposed fifth year review of the pilot.

6.8.3 Inclusion of development offsets

The pilot scheme has focussed on existing sources. With significant development anticipated in the Bramble Bay region, there is the likelihood of new sources of nutrient discharges being established.

To maintain the integrity of the Bramble Bay Bubble, any new WWTP operated by Brisbane Water in the bubble region would need to operate within the existing Bubble load limits. Other new sources however would only need to comply with prevailing development consent conditions, and any nutrient reductions beyond these requirements could in principle qualify as an offset.

Box 2: Pollution Offsets for the Sydney Drinking Water Catchments

The offset scheme for Sydney's drinking water catchments has been proposed under the draft Regional Environmental Plan (REP), *Sustaining the Catchments - A regional plan for the drinking water catchments of Sydney and adjacent regional centres*. A Guideline for the offset scheme was released for public consultation in March 2004 as part of a revised draft Regional Environmental Plan. The discussion below is drawn from that document.

Under the draft REP, development consent cannot be given unless the development can demonstrate a "neutral or beneficial effect" on water quality. The offset scheme would allow a development proposal to demonstrate a "neutral or beneficial effect" on water quality by offsetting any additional nutrient or sediment pollution.

Pollution offsets will be considered on a case-by-case basis by negotiated agreement, and will be based on ratios that account for the risk and uncertainty of offsets, so as to ensure developments and activities have a neutral effect on water quality in the long term.

Developers may agree to participate in pollution offsets if a development proposal:

- Requires development consent under Part 4 or approval under Part 5 of the *Environmental Planning and Assessment Act 1979*, and
- Is expected to increase discharges of nitrogen, phosphorus and/or sediment leaving the site, and
- Is unable to meet the neutral or beneficial effect test without a pollution offset.

Offsets will either be:

- Performed by the developer under the supervision of the SCA, or
- Paid for by the developer, in accordance with the contributions schedule and performed by the SCA.

A "Duty of Care" criterion for participating landholders is envisaged. Landholders will be expected to demonstrate that they are meeting their statutory obligations and achieving at least minimum environmental standards before additional offsets can be located on their properties. Initially the existence of an appropriate farm management plan may be taken as evidence that the landholder is meeting minimum environmental performance expectations.

Once the Bubble scheme is operating and offsets are proven and available (particularly if there is an established banker or broker), there is the opportunity for development consent conditions to require discharges from new developments to be offset. Initially this could be done on an opportunistic basis with the potential over time to move to compulsory offsets. The latter approach has been adopted by the NSW Government in relation to Sydney's drinking water

catchment (see Box 2), and has been foreshadowed by the Queensland Government for potential application in that state¹⁵.

The Sydney drinking water catchment development offsets have been proposed following the success of the South Creek Bubble Scheme and its evolution to incorporate offsets. The incorporation of development offsets into the Bramble Bay scheme or elsewhere in SEQ will also require the EPA collaborating closely with the Planning agencies and other Healthy Waterways partners.

6.8.4 Move from bubble to permit trading

The potential for a more formal permit trading scheme in the Bramble Bay region has been canvassed in this report. Such a scheme would incorporate a wider set of participating point sources and offer potentially greater trading benefits and compliance cost savings.

With the experience of the Bubble scheme and further investigation into the extent of likely benefits, a decision on moving from the Bubble structure to permit trading could be made. A key consideration would be the cost-effectiveness of further load reductions from Bubble participants relative to new participants.

Under the proposed Bubble, non-Brisbane Water sources in the bubble region can sell abatement effort (offsets) into the Bubble. A permit trading scheme essentially will allow abatement effort (permits) to be sold out of the Bubble. Therefore there will only be gains from moving from the bubble to a permit trading structure if the non-bubble participants are expected to be permit buyers.

Our analysis has suggested that this is likely given postulated load limits and plant configurations. However this situation may change over the life of the bubble, such as with changes in applicable load limits to non-bubble sources and associated management responses.

Importantly, target setting and compliance under the bubble will influence the gains from expanding trading to wider participants under a permit trading scheme. In Section 5.4 it was highlighted that because of the nature of available abatement opportunities, investment and actual load reductions will come in a step-wise fashion. So in the case of the nitrogen target sought under our illustrative example and with the assumed abatement options and costs, there would be a reduction in nitrogen loads some 45 tonnes in excess of the target. Further, it was shown that the new participants under permit trading would look to purchase these surplus credits - the result being a paper trade rather than any change in environmental outcomes.

Another issue associated with moving to permit trading with a relatively small number of participants, is ensuring the market is competitive. Under the bubble framework this is not a

¹⁵ see Section 10 in the *Regulatory Impact Statement for the Amendment to Schedule 1 of the Environment Protection (Water) Policy 1997*, released in May 2005. In the case of discharges to highly modified aquatic ecosystems, offsets of greater than 1:1 may be sought to reverse the trend in water quality.

major consideration, as all point sources are in common ownership. However these sources would hold a large share of permits under an expanded permit trading scheme. Nevertheless, competition concerns can be mitigated through careful scheme design. For example, scheme features employed elsewhere include the promotion of offset sources to provide a greater number of market participants, scheduled permit retirement (or on-going allocation) and reissue via competitive means such as auction, and the use of non-punitive penalties and carry-over provisions.

The most critical issue affecting the move to permit trading schemes more broadly in SEQ, will be in developing robust environmental equivalency relationships. Without this, acceptable regions for trading will be too small to provide sufficient sources to make permit trading worthwhile. As already argued above, this emphasises the need to invest in scientific investigations to develop an appropriate knowledge base to support the evolution of trading instruments.

Support for permit trading schemes is also likely to be greater once broader water quality improvements, and the allocation of improvement effort across major stakeholder groups is agreed. In these circumstances water quality trading initiatives will offer a means for stakeholders to reduce compliance costs, rather than being seen as the means of introducing new environmental performance requirements.

7. KEY ISSUES FOR PHASE 2 OF THE MORETON BAY TRADING STUDY

This study has provided a scoping of opportunities for nutrient trading in Moreton Bay catchment areas. Much of the analysis has focussed on identifying a suitable pilot area that will provide an appropriate range of nutrient sources and abatement opportunities necessary to support trading. The recommended Bramble Bay Bubble Licence Nutrient Trading Pilot focusing on the Bramble Bay area provides this, as well as a trading structure that should maximize benefits from the scheme given the resources that will be required to establish, administer and enforce it.

Early in Phase 2 the EPA should seek to confirm that there are adequate opportunities for rural offsets in the Bramble Bay area. If it is found that there are few rural offset opportunities then the options for the EPA include:

- Continue with Bramble Bay bubble as significant benefits are expected and valuable lessons are likely to be learned through experiences with urban diffuse offsets
- Consider the extent to which environmental equivalence issues can be resolved to allow extension of the Bubble to mid (and upper) Pine catchment where more significant rural diffuse opportunities are likely
- Scope the potential for an additional nutrient trading scheme with a strong focus on rural diffuse offsets.

Two opportunities stand out for gaining more experience with rural diffuse offsets. The first is rural offsets to assist Loganholme WWTP to meet lower licence limits. The current level of treatment at Loganholme and nature of other sources in the Logan-Albert catchment were covered earlier in Section 4.2.

The second opportunity is introducing a bubble (similar to that proposed for Bramble Bay) in the Maroochy/Mooloolah catchment, where significant point sources, active stakeholders and significant rural diffuse abatement opportunities are present.

Opportunities in the Maroochy Mooloolah catchment

The Maroochy catchment includes five WWTPs and four prawn farms. Table 30 shows the WWTPs in the catchment, the location of their discharges and their percentage contribution to current nutrient loads from the point sources.

Table 30: WWTPs in Maroochy Mooloolah catchment

Point sources	% of total point source loads		Location of discharge
	Nitrogen	Phosphorus	
Suncoast	4	3	Maroochy river
Coolum	3	3	Maroochy river
Maroochy	45	46	Maroochy river
Caloundra	12	7	Pacific ocean
Bokarina	37	41	Pacific ocean

WWTPs dominate point source loads and would therefore be key participants in a trading scheme. Table 31 outlines the characteristics of the WWTPs in the Maroochy catchment.

Table 31: Characteristics of the WWTPs in the Maroochy catchment

	Range of values
Share of total point source nitrogen load	3% - 45%
Share of total point source phosphorus load	3% - 46%
Size of WWTP (ML/day)	3 – 24
Average nitrogen discharge concentration (mg/L)	1.9 – 13
Average phosphorus discharge concentration (mg/L)	1 – 5.93

There is diversity in the size and treatment levels of the WWTPs in the catchment. There are some big differences in discharge concentrations, particularly for nitrogen.

Significant diffuse sources in the Maroochy catchment include stormwater from urban areas, and runoff from grazing, on site wastewater systems and intensive agriculture. Agricultural activities make a significant contribution to nitrogen loads (around 47 percent).

The Maroochy Mooloolah catchment is a high profile catchment with strong community involvement.

In section 6.8 the potential evolution of nutrient trading in SEQ was canvassed. A number of actions by the EPA and collaborating agencies could assist that evolution, namely:

- The scoping of parallel opportunities for trading whilst developing & implementing the Bramble Bay Bubble scheme, such as in the Maroochy/Mooloolah Rivers catchment
- Investing in research to establish robust environmental equivalence relationships, particularly in regard to diffuse sources. While existing water quality models incorporate coefficients to reflect these relationships, there was little confidence in them.

- Developing the skills, estimation tools and administrative/enforcement arrangements to promote diffuse source offsets. This could be promoted directly by the EPA or through supporting a suitable third party such as a CMA in developing demonstration offsets and or offset banking.
- Completing the move to establishing load limits in EPA licenses for water pollutants commensurate with load reductions required from these sources under broader water quality management goals and strategies.
- Investigating, with planning authorities, opportunities for development offsets for nutrients in areas where offsets have been developed, noting that this could involve developers paying into a fund held by the EPA or an offset bank, with the funds directed at offset purchases.

The scoping analysis has by necessity relied on readily available information and expert judgements. In Phase 2 of the CCI Moreton Bay study, the data and relationships we have used will need to be confirmed, and appropriate data, models and analytical techniques will need to be assembled to support detailed instrument design. Some of these include:

- Means to estimate nutrient generation rates and abatement associated with potential offsets – such as for different land uses and management practices;
- Water quality models, that can be used to establish environmental equivalence between potential trades and decision-support tools to assist trade reviews and the development of trading rules;
- Improved nutrient load budgets;
- More specific information on marginal nutrient abatement costs at WWTPs, and at other point and diffuse sources.

These informational needs will overlap considerably with the Moreton Bay Waterways and Catchment Partnership programs, including the sustainable loads project and supporting models - including decision support tools such as the Environmental Management Support System and Receiving Water Quality Model for the estuaries and Moreton Bay. These Programs and analytical tools will need to be used to guide the setting of load reduction targets and the equivalence of loads from various sources.

Other key issues relate to the establishment of load limits in EPA licenses and stakeholder consultation.

As discussed in Section 6.3, constraining load limits must be introduced into the Brisbane Water WWTP licenses and appropriately enforced. And as discussed in Section 2.4, failure to do so will prevent any real demand being created, trade from occurring and benefits being realised. The absence of tighter limits on individual dischargers and aggressive enforcement has been the greatest impediment to the success of water quality trading schemes to date.

Consultation with stakeholders will be essential prior to the introduction of the Bubble licensing scheme. In NSW a series of discussion papers were prepared for community consultation on the use of economic instruments for environment protection, prior to the development of proposals for specific schemes.

Consultation with stakeholders and the community on a Bubble licensing scheme needs to link into consultation and communication programs being progressed by the Moreton Bay Waterways and Catchment Partnership. Following development of the environmental targets under the scheme and stakeholder acceptance of these, the likely merits of the Bubble approach compared to other policy alternatives to meet the targets needs to be demonstrated.

At a minimum, the following parties need to be consulted on the proposed Bubble licensing scheme:

- Moreton Bay Waterways and Catchment Partnership
- Brisbane Water
- Pine Rivers Shire Council,
- Purac, BP, Caltex and Incitec
- Local Governments within the Bramble Bay area
- Catchment Management Groups within the Bramble Bay area
- Environment groups
- Community groups, particularly representative associations of potential diffuse source offsets (e.g. agricultural, hobby farmers, riparian rehabilitation, etc)

A final consideration that should be investigated in the Phase 2 study, is the extent to which other State policies will be supporting or otherwise. For example, State Government subsidies to Local Government for approved capital works on waste sewerage infrastructure (up to 40 percent) and on sewerage effluent reuse infrastructure (up to 50 percent), has underpinned the wastewater treatment plant upgrades and reuse in SEQ to date. However these incentives will work against diffuse source offsets if such offsets do not also become eligible for equivalent funding support.

GLOSSARY/ACRONYMS

BAU – Business as usual

Bubble scheme – a bubble scheme sets an overall pollution limit over a small number of sources of pollution, allowing them to decide on the best way to meet the overall limit. It is referred to as a bubble licence where a single licence sets an overall limit for a number of activities regulated under the one licence.

Cluster – A geographical area within which any two sources of pollution of the same type/nature are likely have a similar environmental impact. In this report clusters are generally groups of estuaries, rivers or bays or parts of estuaries, rivers or bays. A cluster may be contained within a catchment or may cut across catchments.

Diffuse sources – sources where discharges do not come from a single point, and where the source is not easily identifiable e.g. runoff after rain.

Environmental equivalence – refers to the difference between the impacts of pollution from different sources on an environmental issue. For example, and environmental equivalence ratio of 1:2 for two sources means that 1 tonne of pollutant from the first source is expected to have a similar impact on environmental amenities to 2 tonnes from the second sources.

Offsets – Offsets refer to abatement actions undertaken off site that are used to meet pollution limits. The pollution limits could be part of licence conditions, planning requirements or permit conditions under a trading scheme.

Permit trading scheme – a permit trading scheme involves placing a cap on the overall load of pollutants from a range of sources of pollution. Permits are allocated to participants setting the amount of pollution each source is allowed to discharge. Participants are able to trade in order to meet their permit requirements.

Point sources – sources where discharges come from a single defined point, such as wastewater treatment plants and industrial activities.

SEQ – South East Queensland

Tradeable discharge rights – refers to the suite of policy instruments that create a market in the rights to discharge pollutants. Examples include development offsets, bubble schemes and trading schemes.

WWTPs – Wastewater Treatment Plants

REFERENCES

- BDA Group, *Tradeable Discharge Rights to Reduce Nutrient Pollution in the Port Waterways Catchment, Final Report*, June 2004.
- Beal, C. et al, *Audit of Non-Sewered areas in SEQ*, prepared for Moreton Bay Waterways and Catchments Partnership, December 2003.
- Breetz, Fisher-Vanden, Garzon, Jacobs, Kroetz and Terry (2004), *Water Quality Trading and Offset Initiatives in the US: A Comprehensive Survey*, Dartmouth College Hanover, New Hampshire.
- Brisbane Water, *Brisbane Water Annual Monitoring Report to EPA*, September 2004.
- Debus, *First sod turned in innovative South Creek Scheme*, Minister for the Environment Press Release 27 February 2004.
- Ecosystem Marketplace, *Backgrounder: United States Water Pollutant Trading and Offsets*, 2005.
- Faith (2000), *Fertile Ground: nutrient trading's potential to cost-effectively improve water quality*, World resources Institute, Washington
- Grippio (2003), *Pollutant allowance trading systems offer a new opportunity for improving water quality. How enforceable are they?* Stormwater Vol. 4 (1)
- Healthy Waterways, *Management responses, What is happening to improve our waterways? Report Card, October 2004*, Ecosystem Health Monitoring Program.
- Institute for Sustainable Regional Development, Central Queensland University, *Considering the economic and social impacts of protecting environmental values in specific Moreton Bay/SEQ, Mary River Basin/Great Sandy Strait Region and Douglas Shire Waters*, March 2005.
- King, *Crunch time for water quality trading*, Choices 20(1), 2005, pp 71-75.
- NSW EPA, *Pollution Reduction Trading Scheme for South Creek – Pilot Proposal*, 2002.
- Read Sturgess & Associates, *Economic benefits of nutrient load reduction in the Port Phillip Catchment, Scoping Study*, January 2001.
- Wastewater Futures Pty Ltd, *Technical Review: Best Management Practice for Wastewater Treatment Plants and Re-Use Options in SEQ*, 2005.
- WBM Oceanics Australia, *Estimation and Allocation of Total Maximum Pollutant Loads to achieve Water Quality Objectives in SEQ Waterways Stage 10b report*, March 2005.
- Wastewater Futures Pty Ltd, *Technical review: Best Management Practice for Wastewater Treatment Plant and Re-Use Options in SEQ*, 2005

Appendix 1: Catchment evaluations

Table A1: Summary of catchment review and shortlisting

Catchment	Shortlist	Reasons for shortlisting/culling
Lower Brisbane River	√	Important for Bramble Bay (poorest of all Bay zones) as well as having very poor ecosystem health in the estuary. Some diversity of pollutant sources. WWTPs and urban areas are the major contributors.
Pine Rivers	√	Important for Bramble Bay (poorest of all Bay zones) as well as having poor ecosystem health in estuary. Good diversity of pollutant sources. There are significant contributions from urban areas, WWTPs, grazing and intensive agriculture.
Logan/Albert Rivers	√	Important for Southern Moreton Bay as well as having very poor ecosystem health in estuaries. Some diversity of pollutant sources. The main contributors are WWTPs, urban areas and grazing.
Caboolture River	√	Important for Deception Bay as well as having poor ecosystem health in estuary. Good diversity of pollution sources. Major classes are urban areas, grazing, WWTPs and intensive agriculture.
Bremer River	√	Very poor ecosystem health in estuary. Very good diversity of pollution sources. There are significant contributions from grazing, urban areas, broadacre agriculture, WWTP and meat processing.
Maroochy/ Mooloolah Rivers	X	There is a diverse set of classes of pollutant sources, particularly for nitrogen, and there is potential for a trading instrument to play a role in addressing the gap between current and target loads. However, pollutant reductions in this catchment will not reduce impacts on Moreton Bay.
Gold Coast	X	The WWTP dominates phosphorus loads and the key target for improvement to meet water quality objectives is reducing phosphorus loads. It is therefore unlikely that a trading instrument would offer significant gains over traditional approaches.
Redland Creeks	X	There are a number of licensed sources and good diversity of sources for trading. The Redland Creeks drain into Waterloo Bay. However, both the creeks and Waterloo Bay are in good condition and it is therefore not a priority area for improvement.
Pumicestone	X	There are only two regulated sources in the catchment and one WWTP dominates the loads from these.
Noosa River	X	There is only one regulated source and the Noosa River catchment has good ecosystem health.
Lockyer Creek	X	There are no significant regulated sources in the catchment.
Stanley River	X	No diversity of pollution sources - grazing dominates.
Upper Brisbane R	X	No diversity of pollution sources - grazing dominates.
Mid Brisbane R.	X	No diversity of pollution sources - grazing dominates.

Lower Brisbane

Environmental

The Lower Brisbane catchment covers 980 km². There are some natural areas and grazing lands in the upper parts of the catchment. The majority of the catchment has been extensively modified for urban and suburban development.

The Brisbane estuary has the poorest ecosystem health in SEQ (along with Logan/Albert). The catchment also impacts directly on Bramble Bay. Bramble Bay has the poorest ecosystem health of all Moreton Bay zones and the Brisbane river is a major contributor to this. The EPA has indicated that Bramble Bay is a high priority for environmental improvement. Cleared and agricultural land in the upper parts of the Brisbane river contribute the majority of sediment to the Moreton Bay system (along with the Logan river). Brisbane river also has an impact on Waterloo Bay (currently the healthiest of the western embayments).

Recent modeling work from the sustainable loads project indicates that a reduction of around 84 percent of current nitrogen loads and 97 percent of phosphorus loads could be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways).

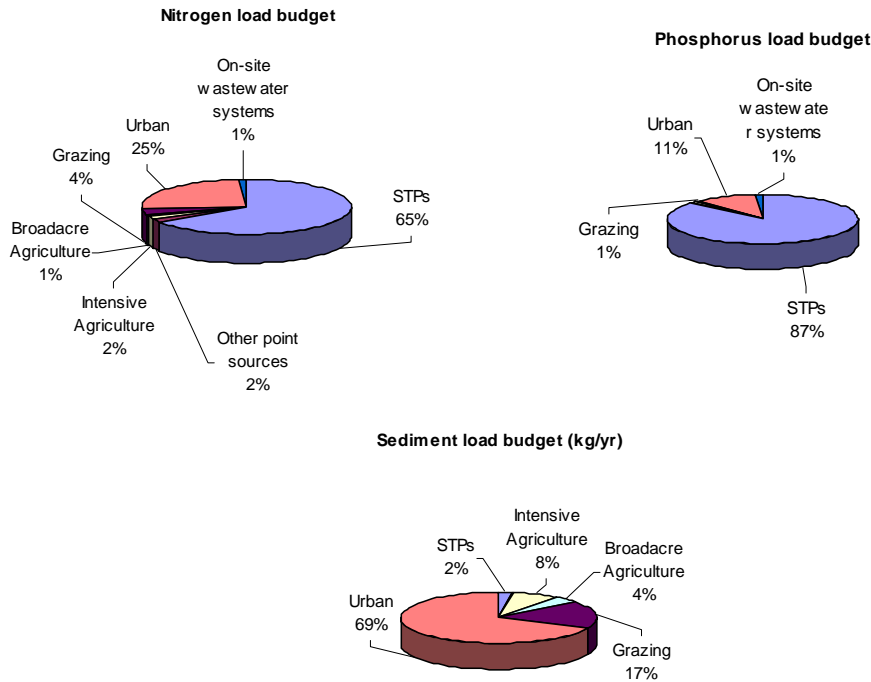
Preliminary EPA advice suggests that point sources within the Bramble Bay Cluster (Lower Brisbane Estuary, Pine River Estuary and Cabbage Tree Creek Estuary) would have an environmental equivalence of 1:1 (if other equivalency tests were also passed). The EPA has indicated that the equivalence between estuary point sources and freshwater diffuse sources is likely to be 1 : High (e.g. around 1:100) in most situations.

The SEQ regional water quality model and EMSS catchment model covers the lower Brisbane. No other specific models have been developed.

Economic

There is a mix of point and diffuse sources and regulated and unregulated sources in the catchment. However, the WWTP and urban areas dominate nitrogen loads and the WWTPs dominate phosphorus loads (see pie charts below). Urban areas dominate sediment loads.

There are around ten WWTPs licensed by the EPA as well as two oil refineries and a fertilizer manufacturer discharging in the catchment. There are also 7 abattoirs and 6 feedlots. These activities are not licensed, however, they are not permitted to discharge nutrient or sediment loads to waters. Diffuse pollution sources include grazing, broadacre agriculture and some intensive agriculture. Population growth is a major pressure on the catchment.



Point source loads are expected to grow by 34 percent for nitrogen and 29 percent for phosphorus by 2026. Diffuse loads are expected to grow by 18 percent for nitrogen and 24 percent for phosphorus.

Stakeholder

WWTPs with load limits facing increasing populations may be willing to participate in a trading instrument if it provides a cheaper alternative to better treatment. There is a Brisbane Catchments Network and a Brisbane Regional Environmental Council.

Regulatory

Most WWTPs have load limits for nitrogen discharges, whereas concentration limits are generally used to manage phosphorus loads.

Strategic

Population growth and urban development is a key issue for the Government.

Preliminary assessment

Reducing pollutant loads in the Lower Brisbane catchment could have a big impact on one of the highest priorities in Moreton Bay – improving the ecological health of Bramble Bay. A trading instrument could facilitate trades between the WWTPs and abatement actions in urban areas to reduce the cost of WWTPs meeting their load reduction targets. It should be recognised that the instrument would not provide any experience or engagement with agricultural activities.

Assessment of Lower Brisbane: **HIGH FEASIBILITY PILOT CATCHMENT**
Pine Rivers Catchment

Environmental

The Pine Rivers catchment covers around 700 km². The headwaters of the North and South Pine rivers are in Brisbane forest park and Bunyaville State Forest. The mid reaches flow through residential areas. The Pine River estuary has very poor ecosystem health. The Pine River is also a major contributor to the poor ecosystem health of Bramble Bay (the Bay with the poorest health of all Moreton Bay zones).

Recent modeling work from the sustainable loads project indicates that a reduction of around 85 percent of current nitrogen loads and 95 percent of phosphorus loads could be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways).

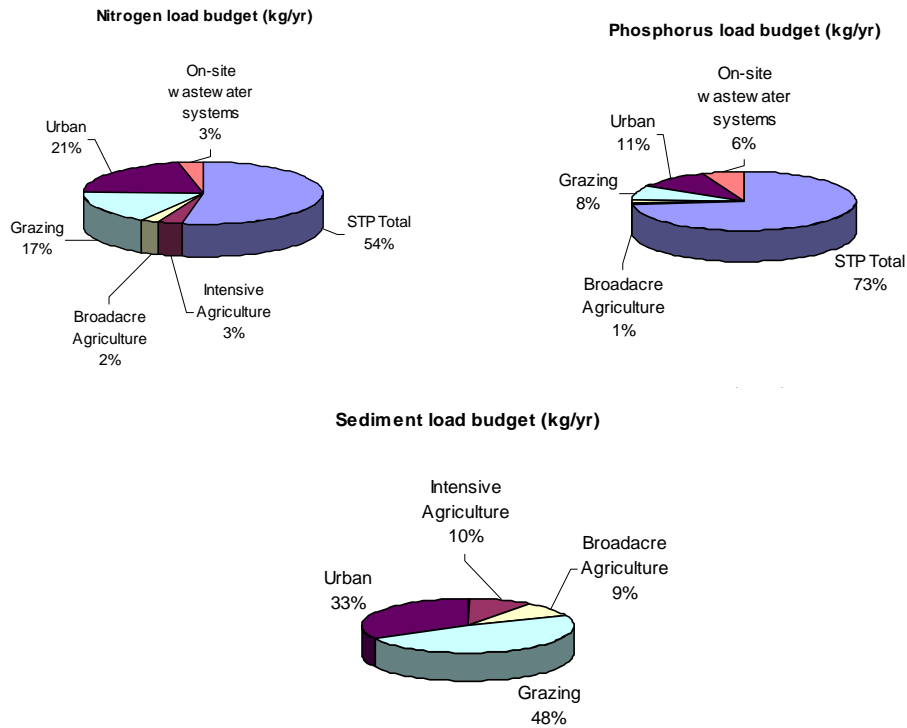
Preliminary EPA advice suggests that point sources within the Bramble Bay Cluster (Pine River Estuary, Cabbage Tree Creek Estuary and Lower Brisbane Estuary) would have an environmental equivalence of 1:1 (if other equivalency tests were also passed). The EPA has indicated that the equivalence between estuary point sources and freshwater diffuse sources is likely to be 1 : High (e.g. around 1:100) in most situations.

The SEQ regional water quality model and EMSS catchment model covers the Pine Rivers catchment. There is a model of Bramble Bay available. No other specific models have been developed for this catchment.

Economic

There is moderate diversity in the classes of pollutant sources in the Pine Rivers catchment. WWTPs, urban areas and grazing activities all make big contributions to pollution loads (see pie charts below). The WWTPs and urban areas dominate nitrogen loads. The WWTPs dominate phosphorus loads and the grazing and urban areas dominate sediment loads.

There are a number of point sources licensed by the EPA including five WWTPs. One WWTP contributes around 60 percent of total phosphorus loads. However, the load shares for nitrogen are more even across the WWTPs. Diffuse pollution sources include grazing, broadacre and intensive agriculture and on-site wastewater systems. Residential development is the major pressure on the catchment with land clearing for moderate and high-density urban development.



The WWTP loads are expected to increase by around 40 percent by 2026. Diffuse loads are also expected to increase by 10 percent for nitrogen and 17 percent for phosphorus.

Stakeholder

New residential developers may be willing to participate in a trading instrument in order to gain approval. There is a Pine Rivers Catchment Association.

Regulatory

The major WWTP has a load limit for nitrogen.

Strategic

The pressure for new development is a key issue for the Government.

Preliminary assessment

Reducing pollutant loads in the Pine Rivers catchment could have a big impact on the health of its estuary as well as Bramble Bay. There is reasonable diversity in the classes of pollutant sources. There is potential for a trading instrument to play a role in addressing the gap between current and target loads and/or coping with new residential development.

Assessment of Pine Rivers: HIGH FEASIBILITY PILOT CATCHMENT

Logan/Albert Rivers Catchment

Environmental

The Logan/Albert is a large catchment covering around 3700 km². The upper reaches of the Logan have been cleared for agriculture and the mid and lower reaches flow through rural residential and urban areas before flowing into Southern Moreton Bay.

Pollutant reductions in this catchment would reduce impacts on high priority environments in Moreton Bay. The estuaries in the catchment have the poorest ecosystem health in SEQ (along with Brisbane/Bremer). The cleared and agricultural land in the upper Logan contributes the majority of sediment to the Moreton Bay system (along with Brisbane river). The high turbidity levels in the catchment are in part attributable to the Marburg soils (mainly in the upper Logan) that are easily eroded and have a greater tendency to travel and cause environmental impacts.

Recent modeling work from the sustainable loads project indicates that a reduction of around 91 percent of current nitrogen loads and 97 percent of phosphorus loads would be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways). The sustainable loads project is being coordinated by the Moreton Bay Partnership.

From preliminary advice from the EPA it appears that environmental equivalence ratios could be established to represent the relative impacts of different point sources. Point sources within the lower Logan Estuary cluster (lower Logan Estuary and part of Southern Moreton Bay) may have an environmental equivalence of 1:1 (if other equivalency tests were also passed). Point sources within the Logan/Albert Estuary cluster (upper Logan Estuary and Albert Estuary) may also have an equivalence of 1:1 (if other equivalency tests were also passed). The EPA has indicated that the equivalence between estuary point sources and freshwater diffuse sources is likely to be 1 : High (e.g. around 1:100) in most situations.

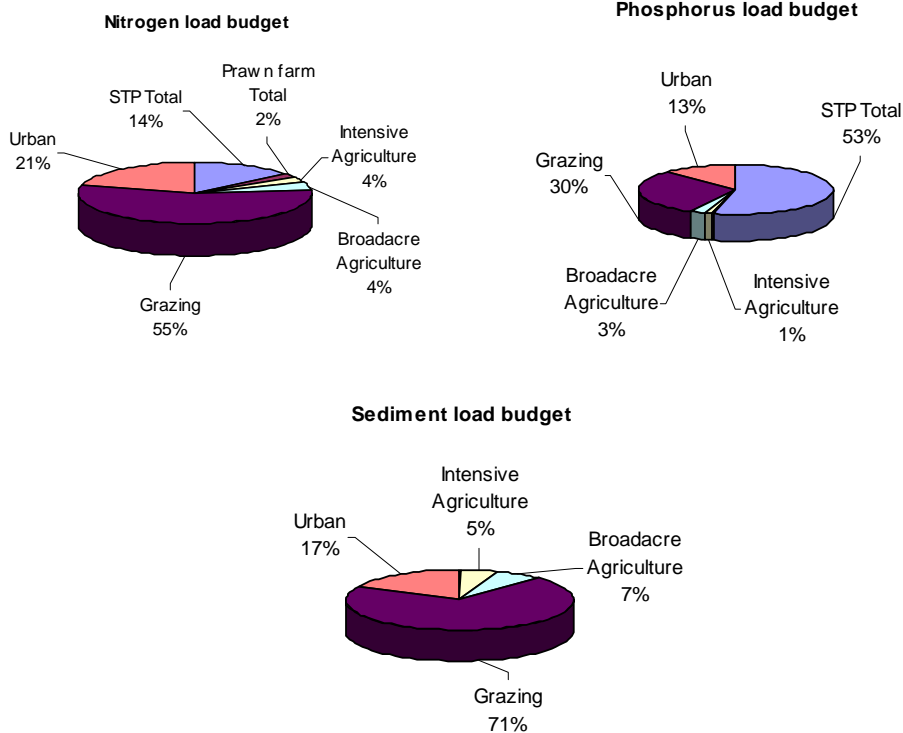
The SEQ regional water quality model and EMSS catchment model covers the Logan Albert. No other specific models have been developed for this catchment. The Moreton Bay Partnership has studied sediments in Moreton Bay and this may provide information on the impact of the Marburg soils. The EPA has undertaken some work on relative loads from prawn farms and other catchment loads which may also be useful.

Economic

There is a diverse set of classes of pollutant sources in the Logan Albert catchment and a good mix of point and diffuse and regulated and unregulated sources. Grazing activities, WWTPs and urban areas all make big contributions to pollution loads (see pie charts below). There is greatest diversity of classes for nitrogen loads. The WWTPs dominate phosphorus loads and the grazing areas dominate sediment loads.

There are a number of point sources licensed by the EPA including four WWTPs and around ten aquaculture operations/prawn farms. One WWTP discharges more than 60 percent of the

total point source loads of nitrogen and around 90 percent of point source phosphorus loads. There are three abattoirs, around fifteen feedlots and a piggery. These sources are not licensed, however, they are not permitted to discharge nutrient or sediment loads to waters. Diffuse pollution sources include grazing, dairies and irrigated agriculture.



There are also likely to be new sources in the future with increasing pressure for an expansion of aquaculture activities as well as urban development in the catchment. By 2026 nitrogen loads from point sources are expected to increase by 29 percent and phosphorus loads by 33 percent. Loads from diffuse sources are expected to increase by 13 percent and 18 percent respectively.

Stakeholder

Aquaculture operators wishing to expand their activities may be willing to participate in a trading instrument in order to gain approval. A demonstration site has been set up in Rocky Creek under the Riparian Rehabilitation Demonstration Program. The program involves tree planting, fencing, stock exclusion, provision of off-stream watering facilities and weed removal. This demonstration site may have provided some groundwork for landholder acceptance of diffuse water pollution issues and confidence in management measures.

There is a community based Logan Albert Rivers Catchment Association that undertakes riparian restoration and management activities.

Regulatory

The EPA's licensing system could provide a framework to support some form of trading in the catchment. EPA licences for prawn farms in the Logan River contain load limits for both nitrogen and phosphorus. The WWTPs do not currently have load limits in their licences (apart from Loganholme WWTP which has a limit for nitrogen). The WWTP discharges are controlled through concentration limits.

New aquaculture activities require approval under planning legislation. However, this legislation does not currently allow for off-site measures to meet on-site approval conditions.

Strategic

The pressure for expansion of aquaculture is a priority issue for the Government.

Preliminary assessment

Reducing pollutant loads in the Logan Albert catchment could have a big impact on the health of its estuaries as well as Southern Moreton Bay. There is a diverse set of classes of pollutant sources, particularly for nitrogen, and many of the abatement actions that may be carried out to reduce nitrogen would also reduce phosphorus and sediment loads. Given the nature of the Marburg soils it may be that diffuse sources are having a greater impact from this catchment than similar diffuse sources in other catchments. There is potential for a trading instrument to play a role in addressing the gap between current and target loads and/or coping with increased pollution loads from new aquaculture development.

Assessment of Logan Albert: HIGH FEASIBILITY PILOT CATCHMENT

Caboolture River Catchment

Environmental

The Caboolture River catchment extends from the D'Aguilar ranges east to Deception Bay and covers around 600 km². There are major agricultural and rural residential areas as well as three major population centres. The freshwater waterways are in good health. The Caboolture River Estuary has poor to fair water quality and poor biological health. The catchment is a key pressure on the health of the southern portion of Deception Bay.

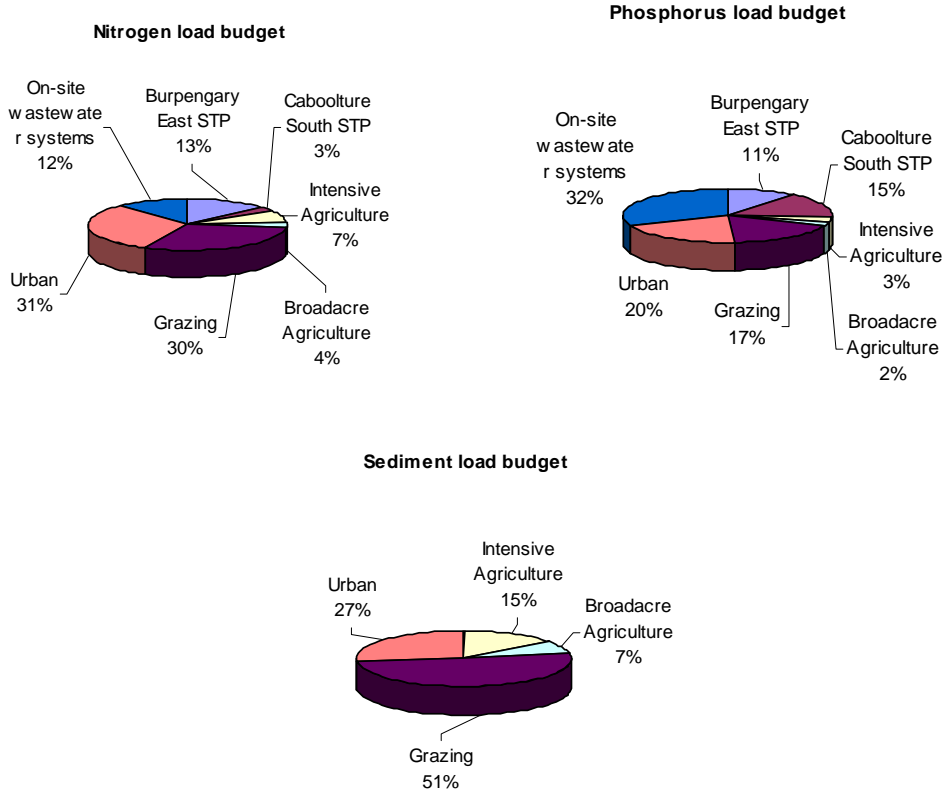
Recent modeling work from the sustainable loads project indicates that a reduction of around 75 percent of current nitrogen loads and 88 percent of phosphorus loads could be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways).

Preliminary EPA advice suggests that point sources within the Caboolture River Estuary would *not* have environmental equivalence of 1:1 as the impacts from an WWTP in the upper part of the estuary are greater. The EPA has indicated that the equivalence between estuary point sources and freshwater diffuse sources is likely to be 1 : High (e.g. around 1:100) in most situations.

The SEQ regional water quality model and EMSS catchment model covers the Caboolture River. No other specific models have been developed for this catchment.

Economic

There is a diverse set of classes of pollutant sources in the Caboolture catchment and a good mix of point and diffuse and regulated and unregulated sources. Urban areas, grazing activities, WWTPs and on-site wastewater systems all make big contributions to pollution loads (see pie charts below). There are three WWTPs licensed by the EPA. One of these discharges to groundwater.



There are significant increases in nutrient loads from point sources by 2026 (of around 44 percent). Smaller increases in loads from diffuse sources are also expected (< 10 percent).

Regulatory

Licensing framework could be used. However, there are no load limits on nutrients discharged from the WWTPs at present.

Preliminary assessment

Reducing pollutant loads in the Caboolture catchment could have a big impact on the health of the Caboolture Estuary as well as Deception Bay. There is a diverse set of classes of pollutant sources and big growth expected in point source loads. There is potential for a trading instrument to play a role in coping with increasing loads. However, the potential for a trading instrument to reduce loads is limited by the small number of licensed sources.

Assessment of Caboolture: MEDIUM FEASIBILITY PILOT CATCHMENT

Bremer River Catchment

Environmental

The Bremer catchment covers around 2000 km². The majority of the catchment has been cleared for cattle grazing. There is one major population centre – the town of Ipswich. The Bremer River Estuary has the poorest ecosystem health in SEQ (along with Logan/Albert). There is widespread gully and channel erosion. Long residence times (190 days) means flushing is not removing pollution loads.

Recent modeling work from the sustainable loads project indicates that a reduction of around 94 percent of current nitrogen loads and 98 percent of phosphorus loads would be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways).

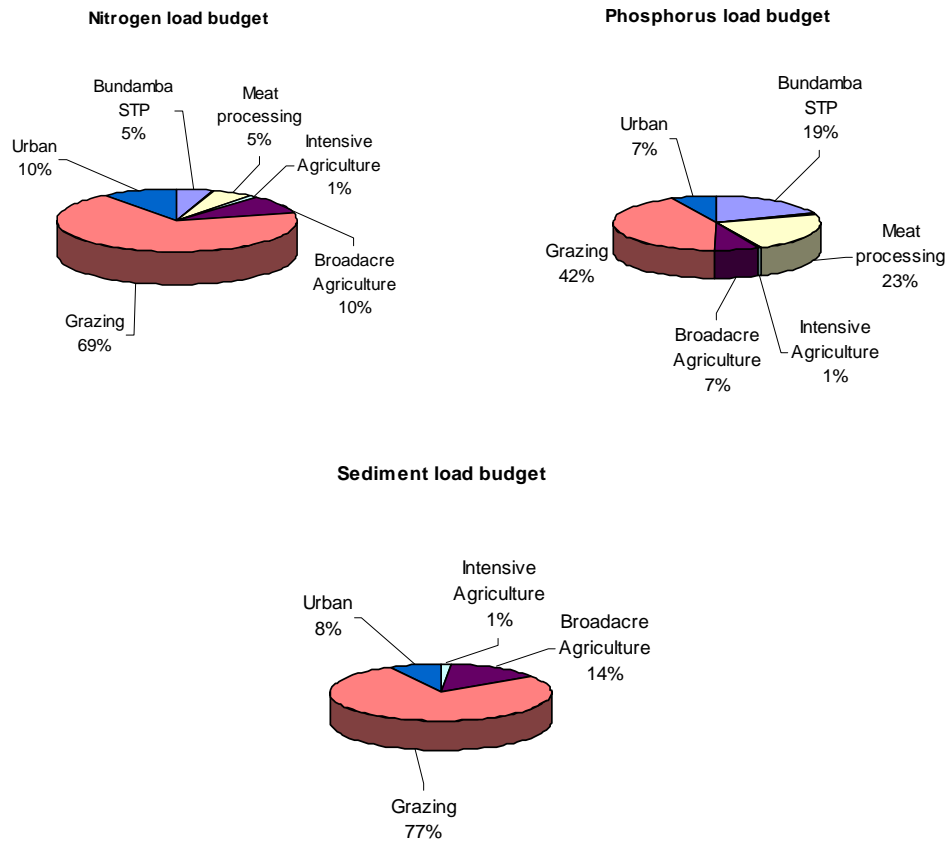
From preliminary advice from the EPA it appears that environmental equivalence ratios could be established between point sources. Point sources within the Upper Brisbane River cluster (Bremer River and Upper Brisbane Rivers) may have an environmental equivalence of 1:1 (if other equivalency tests were also passed). The EPA has indicated that the equivalence between estuary point sources and freshwater diffuse sources is likely to be 1 : High (e.g. around 1:100) in most situations.

The SEQ regional water quality model and EMSS catchment model covers the Bremer. The water quality model has been extended specifically for the Bremer river. An audit of the Bremer river has also been conducted focusing on organic loads and dissolved oxygen.

Economic

There is a mix of point and diffuse and regulated and unregulated sources. Grazing activities, other agricultural activities, WWTPs and urban areas all make significant contributions to pollution loads (see pie charts below). There is greatest diversity of classes for phosphorus loads. Grazing activities dominate sediment loads and contribute over 60 percent of nitrogen and over 40 percent of phosphorus loads.

There are a number of point sources licensed by the EPA including three WWTPs, a power generator and meat processor. One WWTP dominates the WWTP loads. There are two abattoirs, around six feedlots and two piggeries. These sources are not licensed, however, they are not permitted to discharge nutrient or sediment loads to waters. Diffuse pollution sources include grazing, broadacre agriculture and intensive agriculture.



Development in the catchment is a very significant issue. Point sources nutrient loads are expected to increase by around 65 percent by 2026. Diffuse loads are expected to increase by around 13 percent for nitrogen and 19 percent for phosphorus.

Stakeholder

The Ipswich Rivers Improvement Trust, along with the community and local government, carries out tree planting in riparian areas across the catchment. Australian Meat Holdings is a licensee in the catchment and has planted trees at its facility, in conjunction with the Bremer Catchment Association.

Regulatory

The EPA licensing system could provide a framework for trading. There is a nitrogen load limit on the major WWTP and load limits on both phosphorus and nitrogen loads from the meat processing works.

Strategic

A recent proposal for a paper plant has been a difficult issue for the Government.

Preliminary assessment

Reducing pollutant loads in the Bremer catchment could have a big impact on the health of its estuaries. There is reasonable diversity of classes of pollutant sources, particularly for

phosphorus, and many of the abatement actions that may be carried out to reduce phosphorus would also reduce nitrogen and sediment loads. The benefits of using trading to address the gap between current and target loads may be limited, given there are only a small number of licensed sources. However, there is potential for a trading instrument to play a role in coping with the expected increases in pollutant loads over time.

Assessment of Bremer: **HIGH FEASIBILITY PILOT CATCHMENT**

Maroochy/Mooloolah Rivers Catchment

Environmental

The catchment covers around 800 km² and includes several major population centres. The majority of land has been cleared for agricultural purposes - mostly sugarcane and pineapple plantations. The Maroochy estuary has very poor ecosystem health. Nutrients in diffuse agricultural runoff have been identified as a major pressure on the Maroochy river estuary (Ecosystem health monitoring program technical report 2002-03).

Recent modeling work from the sustainable loads project indicates that a reduction of around 49 percent of current nitrogen loads and 68 percent of phosphorus loads would be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways).

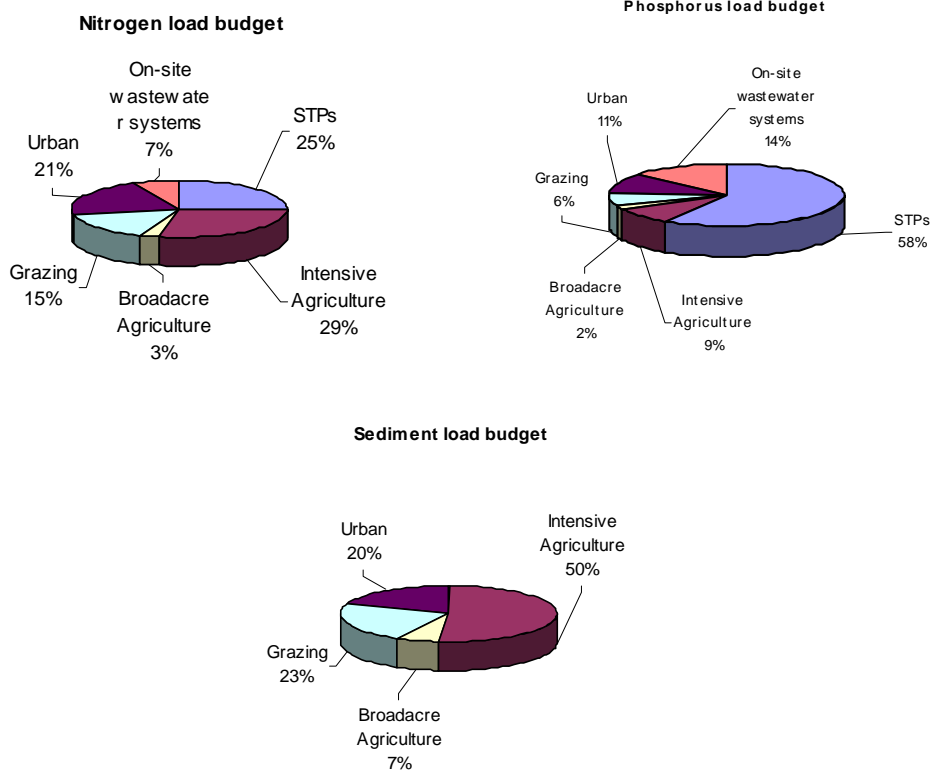
Preliminary EPA advice suggests that point sources within the Lower Maroochy River Estuary may have an environmental equivalence of 1:1 (if other equivalency tests were also passed). The EPA has indicated that the equivalence between estuary point sources and freshwater diffuse sources is likely to be 1 : High (e.g. around 1:100) in most situations.

The SEQ regional water quality model and EMSS catchment model covers the Maroochy Mooloolah. A separate water quality model has been developed for Maroochy as part of the sustainable loads project being co-ordinated by the Moreton Bay Partnership.

Economic

There is a diverse set of classes of pollutant sources in the Maroochy Mooloolah catchment and a good mix of point and diffuse and regulated and unregulated sources. WWTPs, urban areas, intensive agriculture, grazing and broadacre agriculture all make significant contributions to pollution loads (see pie charts below). There is greatest diversity of classes for nitrogen loads. The WWTPs dominate phosphorus loads and intensive agriculture contributes 50 percent of sediment loads.

There are a number of point sources licensed by the EPA including 5 WWTPs and 4 prawn farms. Three WWTPs discharge into the Maroochy river, the other two discharge to the ocean.



Point source loads of nutrients are expected to increase by around 50 percent by 2026. Diffuse source loads of nitrogen are expected to increase by 7 percent for nitrogen and 12 percent for phosphorus.

Stakeholder

The Maroochy Mooloolah catchment has particularly active natural resource management and catchment groups. There are a number of active community organisations including the Maroochy Mooloolah Catchment Coordinating Association, Maroochy Landcare, Maroochy Waterwatch and Mooloolah Waterwatch.

Two demonstration sites have been set up in Echidna Creek and Bunya Creek under the Riparian Rehabilitation Demonstration Program.

Regulatory

The EPA licensing system could be used as a framework for trading. However, at present the WWTPs do not currently have load limits in their licences. Some intensive agricultural activities are regulated by the Department of Primary Industries.

Strategic

The Maroochy Mooloolah catchment is a high profile catchment with strong community involvement.

Preliminary assessment

There is a diverse set of classes of pollutant sources, particularly for nitrogen, and many of the abatement actions that may be carried out to reduce nitrogen would also reduce phosphorus and sediment loads. There is potential for a trading instrument to play a role in addressing the gap between current and target loads and managing the expected growth in loads. Reducing pollutant loads in the Maroochy Mooloolah catchment could have a big impact on the health of its estuaries, however load reductions would not improve Moreton Bay.

Assessment of Maroochy/Mooloolah: MEDIUM FEASIBILITY PILOT CATCHMENT

Gold Coast Catchment

Environmental

There are three main rivers in the Gold Coast catchment that feed into the Broadwater: the Pimpama, Coomera and Nerang rivers. The Broadwater is a relatively healthy system mostly due to oceanic flushing. There is tidal flushing through the Gold Coast Seaway which has been artificially stabilized to prevent the loss of sand. There are natural areas in the upper parts of the Pimpama/Coomera, Nerang/mudgeeraba and Currumbin/Talldbudgera sub catchments. In the lower reaches there are urban areas. The areas surrounding the Broadwater are highly urbanized and modified into canal estates. Flushing within the canals is restricted and this results in elevated residence times.

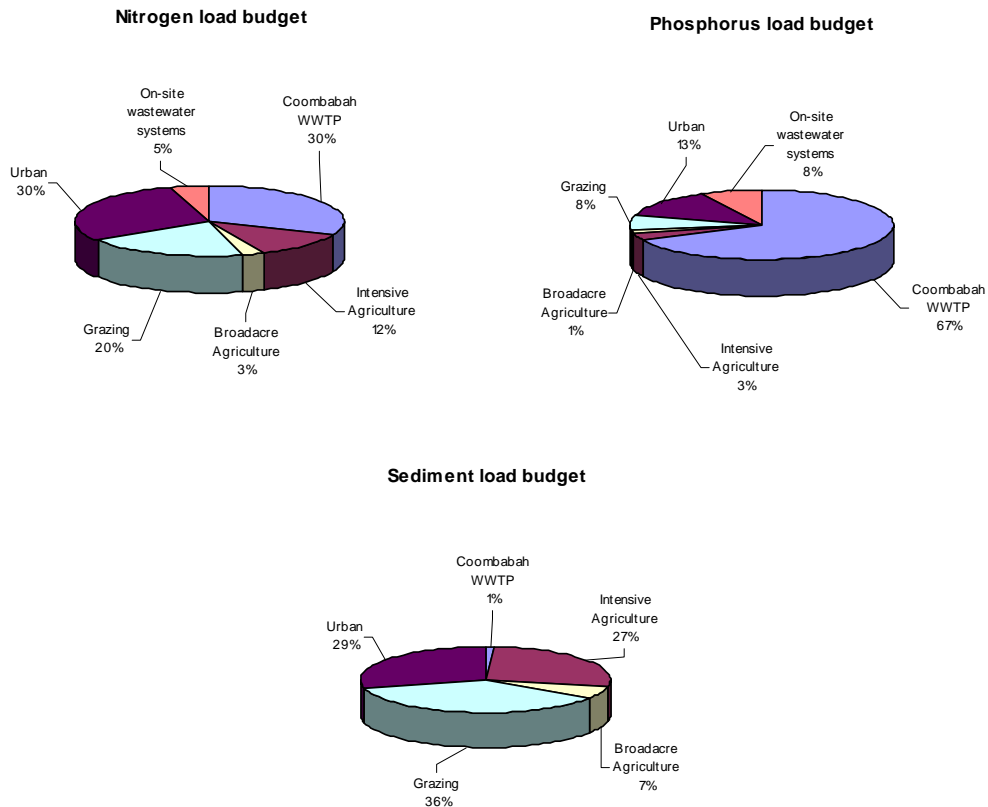
The freshwater systems are in moderate to good health. Most of the estuaries have good water quality and biological health. The exception is the Pimpama estuary which has fair to poor ecosystem health.

Recent modeling work from the sustainable loads project indicates that a reduction of around 11 percent of current nitrogen loads and 60 percent of phosphorus loads could be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways). No reduction in nitrogen or phosphorus loads would be needed to meet water quality objectives for the Broadwater itself.

The SEQ regional water quality model and EMSS catchment model covers the Gold Coast. No other specific models have been developed for this catchment.

Economic

There is a diverse set of classes of pollutant sources in the Gold Coast catchment. However, there is only one activity licensed by the EPA that discharges – an WWTP. The WWTP, urban areas, grazing activities, and other agricultural activities all make significant contributions to nitrogen loads (see pie charts below). There is good diversity of classes for nitrogen and sediment loads. The WWTP dominates the phosphorus loads (contributing 67 percent of the total load). There is also an abattoir that is not permitted to discharge nutrient or sediment loads to waters. Diffuse pollution sources include urban areas, grazing, and broadacre and intensive agriculture.



There are also likely to be new sources in the future with urban development expanding in the catchment. WWTP nutrient loads are expected to increase by 50 percent by 2026. Diffuse loads are expected to increase by 10 percent for nitrogen and 18 percent for phosphorus by 2026.

Stakeholder

New developers may be willing to participate in a trading instrument in order to gain approval.

Strategic

Urban development is a key issue for the Government.

Preliminary assessment

Reducing pollutant loads in the Gold Coast catchment would preserve the health of its ecosystems and the Broadwater. There is a diverse set of classes of pollutant sources for nitrogen and sediments, however the wastewater treatment plan dominates phosphorus loads. As the key target for improvement to meet water quality objectives is reducing phosphorus loads it is unlikely that a trading instrument would offer significant gains over traditional approaches. However, a trading instrument could be used to help protect ecosystem health in the face of new urban development.

Assessment of Gold Coast: **MEDIUM FEASIBILITY PILOT CATCHMENT**

Noosa River Catchment

Environmental

Noosa is the most northern catchment consisting of a series of coastal lakes connected by the main estuary channel. The upper catchment is largely pristine and the urban areas are concentrated in the lower estuarine reaches. The freshwaters are in excellent condition and the Noosa estuary has good water quality and biological health. The catchment is an important tourist destination.

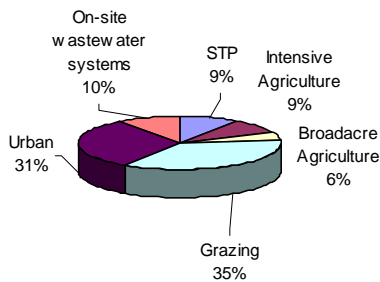
Recent modeling work from the sustainable loads project indicates that no reduction in nitrogen or phosphorus loads would be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways).

The SEQ regional water quality model and EMSS catchment model covers the Noosa catchment. No other specific models have been developed for this catchment.

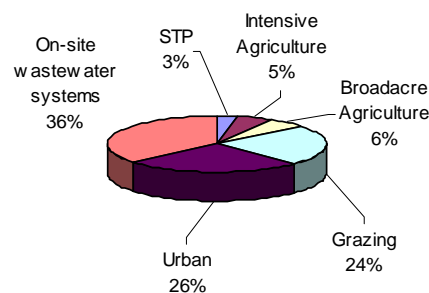
Economic

There is a reasonably diverse set of classes of pollutant sources in the Noosa catchment. Grazing activities, urban areas, an WWTP, on-site wastewater systems and broadacre and intensive agriculture all make significant contributions to pollution loads (see pie charts below). There is a reasonable level of diversity for all pollutants. There is only one licensed point source – the WWTP.

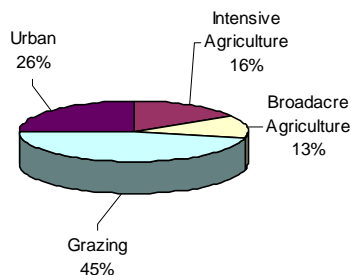
Nitrogen load budget



Phosphorus load budget



Sediment load budget



The WWTP nutrient loads are expected to increase by 8 percent by the year 2026. Diffuse source loads are expected to increase by 3 percent.

Stakeholder

A demonstration site has been set up in Sister Tree Creek to assess the benefits of riparian rehabilitation under the Riparian Rehabilitation Demonstration Program. There is a Noosa Integrated Catchment Coordinating Committee and a Noosa Landcare Group.

Regulatory

The WWTP has no load limits for nutrients.

Preliminary assessment

Reducing pollutant loads in the Noosa catchment could be important for preserving its ecological health and value to Queensland as a tourist destination. There is a diverse set of classes of pollutant sources for all pollutants. However, there is only one point source which does not currently have a load limit. There is some potential for a trading instrument to play a role in coping with any new development proposed for the catchment.

Assessment of Noosa: MEDIUM FEASIBILITY PILOT CATCHMENT

Lockyer Creek Catchment

Environmental

The Lockyer Creek catchment has the highest proportion of land used for intensive agriculture in SEQ. It also has extensive areas of cattle grazing. The upper catchment remains forested. The mid and lower reaches have been cleared for agriculture.

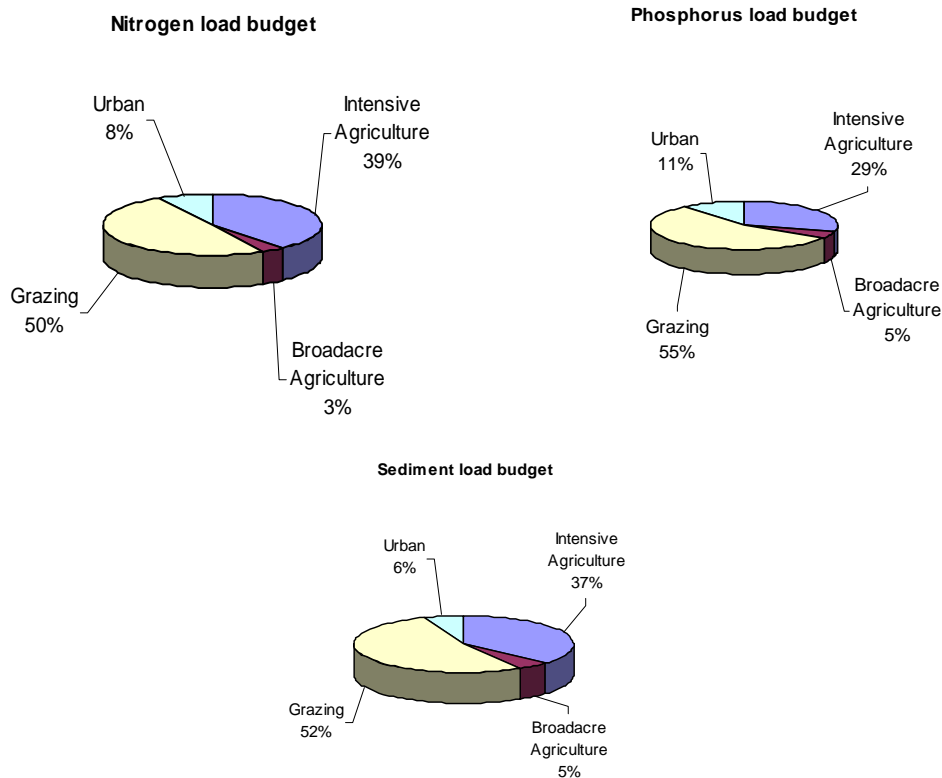
There are areas of poor stream health in the catchment in terms of biological patterns, ecological processes and water quality. There is degraded riparian vegetation, instability of banks, and extensive gully erosion resulting in high sediment loads. Lockyer Creek is a major source of nutrients and sediments entering the Brisbane River and Moreton Bay.

The SEQ regional water quality model and EMSS catchment model covers the Lockyer. No other specific models have been developed for this catchment.

Economic

There is a diverse set of classes of diffuse pollutant sources in the Lockyer catchment. There is one WWTP licensed by the EPA with a very small discharge. Grazing activities, intensive agriculture, broadacre agriculture and urban areas all make significant contributions to pollution loads (see pie charts below). Grazing areas contribute over 50 percent of all pollutant loads. There are a range of different types of activities under intensive agriculture.

There are also 2 abattoirs, 7 feedlots and 4 piggeries. These sources are not licensed, however, they are not permitted to discharge nutrient or sediment loads to waters.



Nitrogen loads from diffuse sources are expected to increase by 12 percent and phosphorus loads by 17 percent by the year 2026.

Stakeholder

A demonstration site has been set up on Blackfellow Creek under the Riparian Rehabilitation Demonstration Program. The SEQ Western Catchments Group is undertaking the Lockyer Green Web Scoping Study to develop practical management actions to improve catchment health.

Preliminary assessment

Reducing pollutant loads in the Lockyer Creek catchment could have a big impact on the health of its ecosystems. There is a diverse set of diffuse pollutant sources, however there is limited information available on the one WWTP. There is potential for a trading instrument to play a role in improving the health of the catchment in a cost-effective way.

Assessment of Lockyer: **MEDIUM FEASIBILITY PILOT CATCHMENT**

Redland Creeks Catchment

Environmental

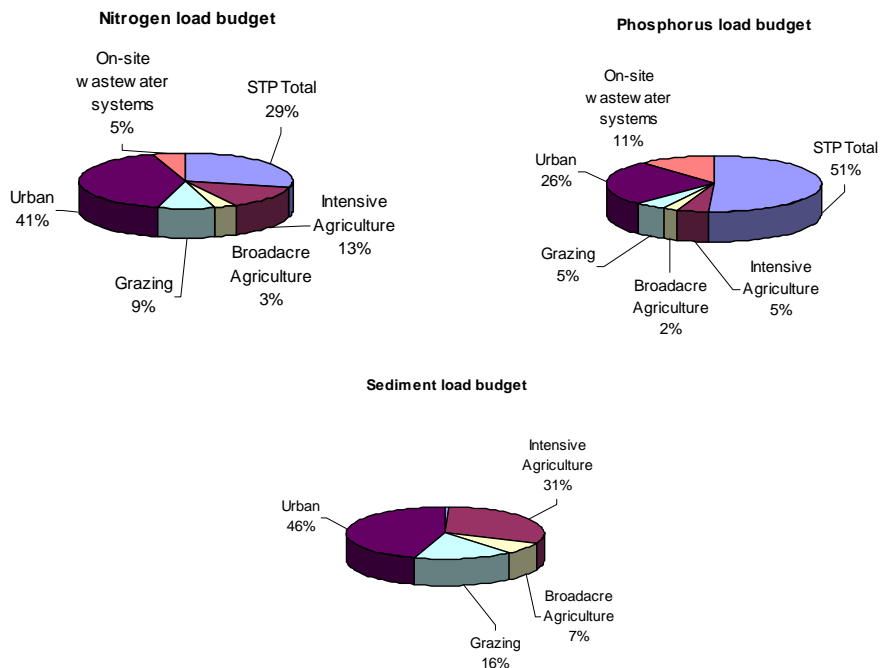
Redland is a small catchment made up of numerous small creeks that drain directly into Waterloo Bay on the western side of Moreton Bay. Rapid urbanisation of the catchment has occurred over recent years. The Redland Creeks themselves are moderately healthy and Waterloo Bay has good water quality and biological health.

Recent modeling work indicates that a reduction of around 90 percent of current nitrogen loads and 95 percent of phosphorus loads could be required to meet water quality objectives in the draft Queensland Water Quality Guidelines 2004 (covering estuarine and coastal waterways).

The SEQ regional water quality model and EMSS catchment model covers Redland Creeks. No other specific models have been developed for this catchment.

Economic

There is a range of classes of pollutant sources in the Redland catchment. WWTPs, urban areas, intensive agriculture, grazing and broadacre agriculture all contribute to pollution loads. There are five WWTPs licensed by the EPA. The largest WWTP contributes around 36 percent of total nitrogen loads and 25 percent of total phosphorus loads.



Regulatory - There are no load limits on the WWTPs.

Preliminary assessment

There are a number of licensed sources in the catchment, good diversity of sources for trading and significant reductions in loads are required.

Assessment of Redlands: MEDIUM FEASIBILITY PILOT CATCHMENT

Stanley River

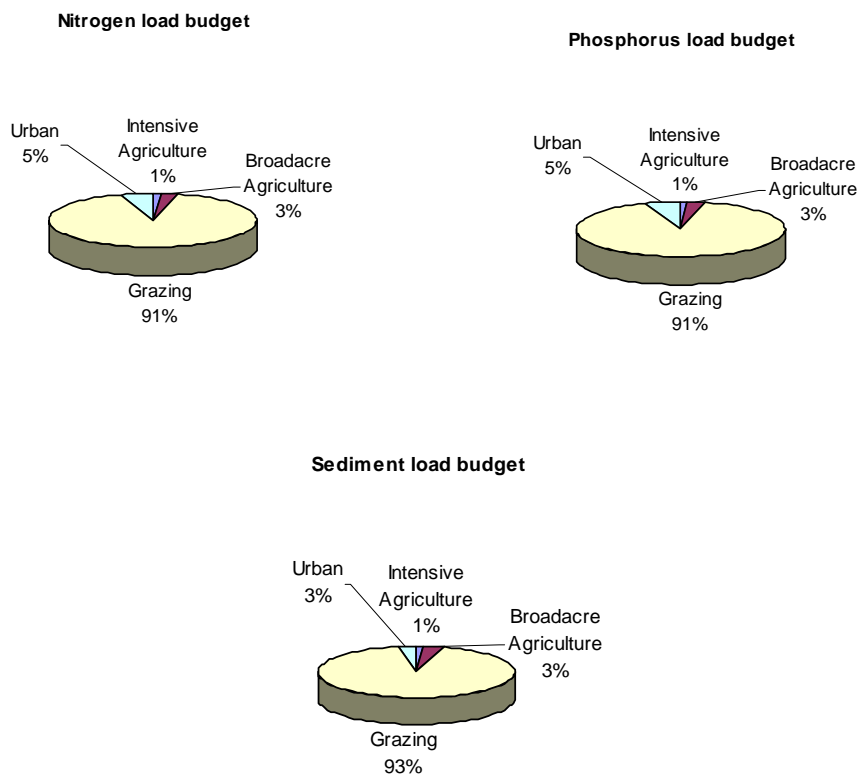
Environmental

The Stanley River is a major tributary of the Brisbane River. Its headwaters are in forested areas, in the mid reaches there is extensive beef and dairy cattle grazing and there are two population centres. The catchment covers around 1500 km². The catchment generally has good water quality and biological health and does not impact directly on Moreton Bay.

The SEQ regional water quality model and EMSS catchment model covers the Stanley River catchment. No other specific models have been developed for this catchment.

Economic

Grazing areas contribute over 90 percent of pollutant loads for all pollutants. There is one sewage treatment plant and one feedlot.



The sewage treatment plant loads are expected to increase, however they will still be a tiny proportion of total loads. The diffuse loads are expected to increase by 2-3 percent by 2026.

Preliminary assessment

The Stanley River catchment has good ecosystem health. There is one main type of activity contributing to pollution loads – grazing. No development pressures have been raised.

Assessment of Stanley: **LOW FEASIBILITY PILOT CATCHMENT**

Upper Brisbane

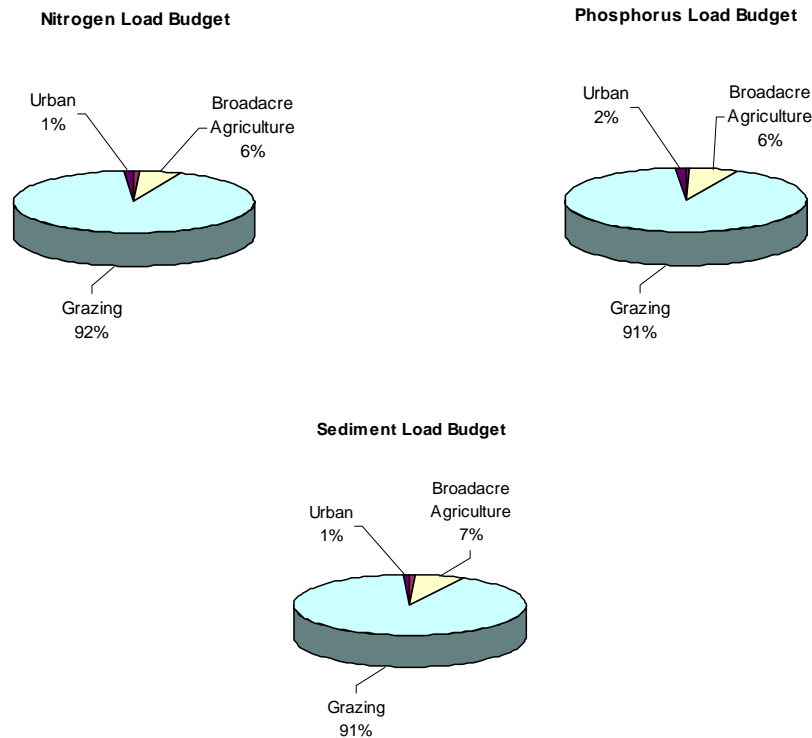
Environmental

The Upper Brisbane catchment covers around 5500 km². There are natural areas in the upper catchment and grazing and rural residential subdivisions in the rest of the catchment. At many locations, cattle have direct access to streams. The Wivenhoe Lake is an effective sediment trap. The majority of sites in the catchment have poor or moderate ecosystem health.

The SEQ regional water quality model and EMSS catchment model covers the Upper Brisbane. No other specific models have been developed for this catchment.

Economic

Grazing areas contribute over 90 percent of pollutant loads for all pollutants. There are no licensed point sources. There is negligible growth in loads expected (<1 percent).



Preliminary assessment

There is one main type of activity contributing to pollution loads – grazing. This limits the potential for a trading instrument to provide benefits over other policy approaches.

Assessment of Upper Brisbane: **LOW FEASIBILITY PILOT CATCHMENT**

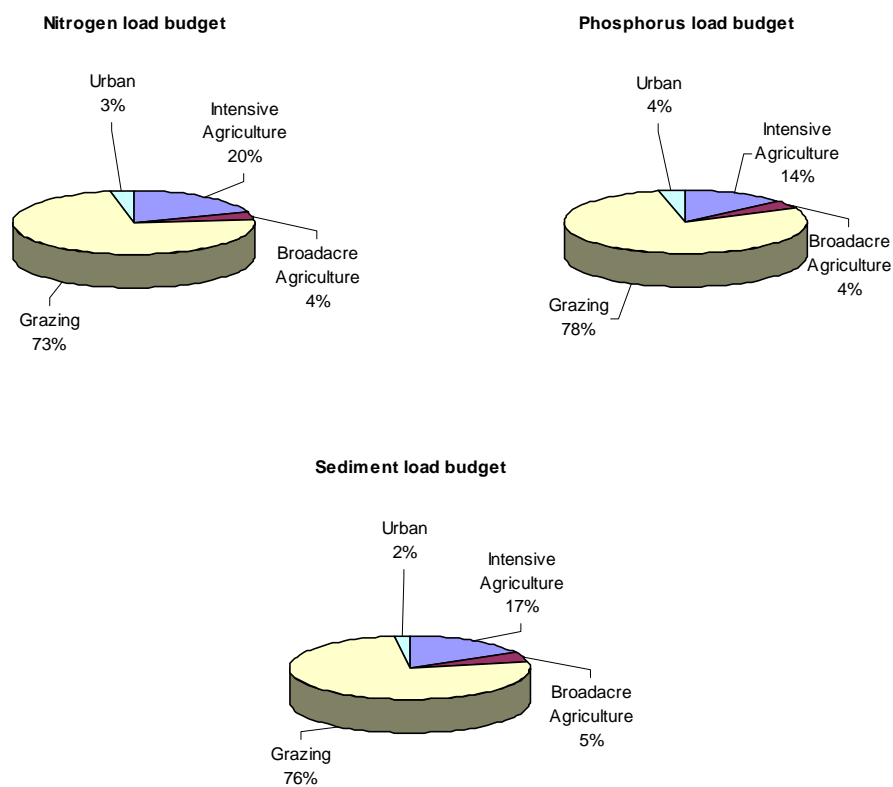
Mid Brisbane

Environmental

Mid Brisbane is a relatively small catchment mostly made up of natural bush, grazing land and managed forests. The mid Brisbane River is in reasonable health. Expansion of agricultural areas has the potential to degrade riparian zones. The SEQ regional water quality model and EMSS catchment model covers mid Brisbane.

Economic

Grazing dominates, contributing over 70 percent of loads for each pollutant. There are no licensed sources. A small increase in diffuse loads is expected by 2026 (around 5 percent).



Preliminary assessment

A trading instrument could play a role in coping with the impacts of new agricultural development. However, given the low diversity of pollution sources, it is unlikely that a trading instrument would reduce the costs of meeting this objective.

Assessment of Mid Brisbane: LOW FEASIBILITY PILOT CATCHMENT

Appendix 2: Regulatory requirements relating to nitrogen for WWTPs in Bramble Bay

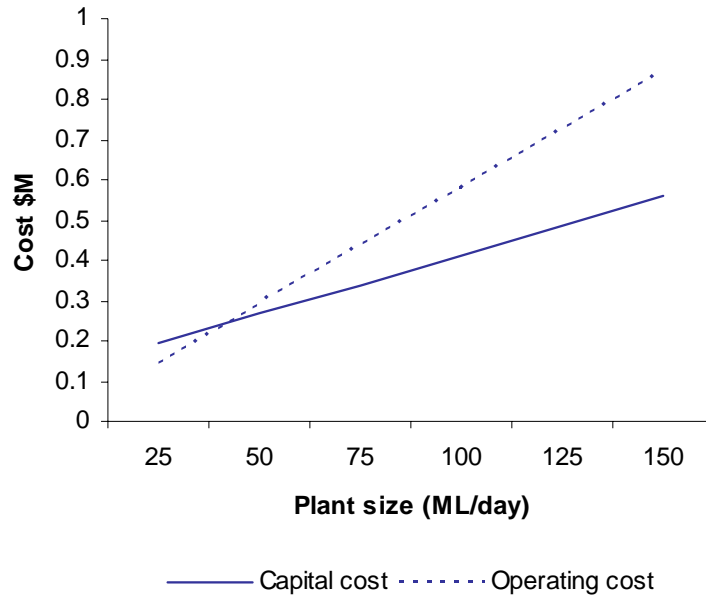
Table A2.1: Regulatory requirements relating to nitrogen loads for WWTPs in Bramble Bay (tonnes per year)

WWTP	2026 nitrogen load under BAU	2009 load limit
Luggage Point WWTP	368	274
Oxley Creek WWTP	137	122
Gibson Island WWTP	70	91
Wynnum WWTP	20	14
Fairfield WWTP	41	12
Sandgate WWTP	54	46

Appendix 3: Costs of nutrient abatement by WWTPs

Figure A3.1 below shows preliminary estimates of the order of magnitude of the costs of metal salt dosing to reduce phosphorus. The figure assumes a simple linear relationship between cost and plant size and the lines are based on estimates for a small and large plant provided by Brisbane Water.

Figure A3.1: Cost of metal salt dosing to reduce phosphorus

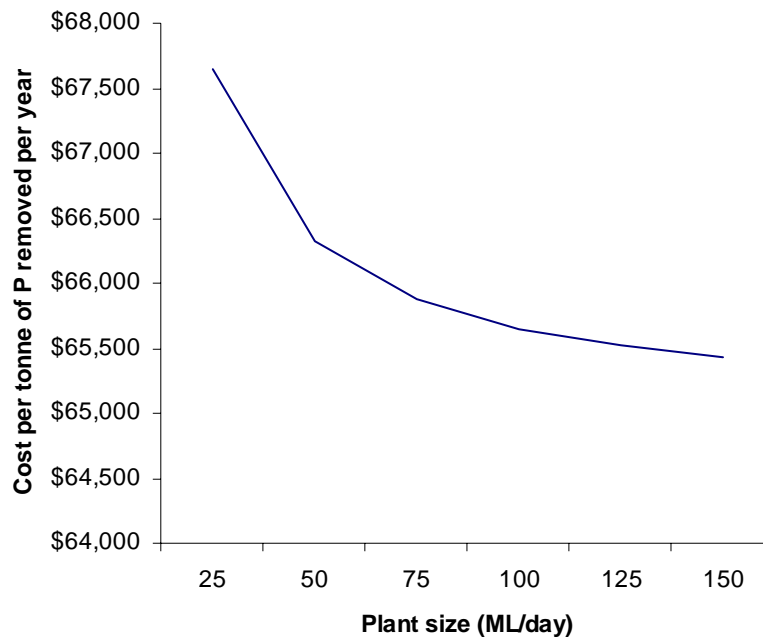


Notes: Preliminary estimates based on information provided by Brisbane Water on costs of options for phosphorus removal at Luggage Point.

The cost estimates reported in the figure are total costs over a 20 year period. The capital costs include storage and dosing pumps. The operating costs include the cost of the chemicals and they are more than half the total costs for all plants with a flow over around 40 ML/day. It should be that there are other costs that may be associated with this option that have not been estimated here. This includes increases in costs as a result of increases in sludge volume, operator requirements and the need for mixing equipment.

The metal salt dosing option is expected to achieve reduce phosphorus concentration in effluent to around 2 mg/L. The cost-effectiveness of the option for different size plants is shown in Figure A3.2. Cost-effectiveness is calculated as the total cost divided by the annual reduction in tonnes of nutrients in discharges. The total cost is over 20 years and includes capital plus the present value of annual operating costs.

Figure A3.2: Cost effectiveness of reducing phosphorus for different plant sizes



Notes: The estimates are based on a reduction in phosphorus concentration in effluent from around 7 mg/L to around 2 mg/L.

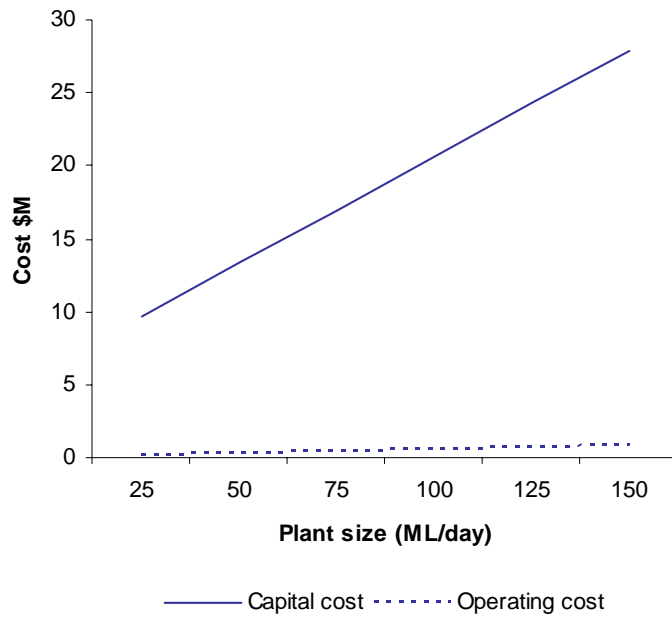
The cost-effectiveness of this option does not vary much across different plants sizes where they are all reducing phosphorus concentrations in effluent from the same level.

An alternative option for phosphorus removal is lime dosing with additional tertiary filtration. Lime dosing is expected to be able to reduce phosphorus concentration in effluent to around 0.5 mg/L. This option is more expensive with capital costs of \$15-\$20m for a large plant. The cost-effectiveness is estimated to be higher than metal salt dosing, ranging from around \$65,000 per tonne of phosphorus removed per year (for a 150 ML/day plant) to \$110,000 (for a 25 ML/day plant) assuming the original nitrogen concentrations in effluent are around 5 mg/L.

The estimated capital and operating costs of reducing nitrogen through tertiary filtration is shown in Figure A3.3.

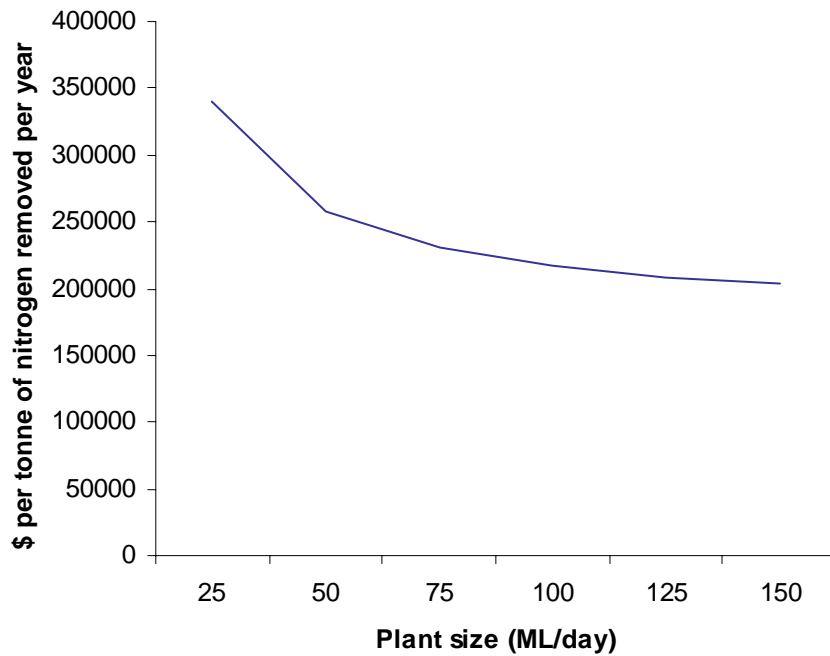
Compared with the metal salt dosing option for phosphorus, the capital costs for reducing nitrogen further are much greater and the capital costs a greater proportion of total costs. As a result the cost-effectiveness varies much more across plants of different sizes. This is shown in Figure A3.4.

Figure A3.3: Costs of tertiary filtration to reduce nitrogen



Notes: Preliminary estimates based on discussions with Brisbane Water. The estimates are based on a reduction in nitrogen concentration in effluent from around 5 mg/L to around 2 mg/L.

Figure A3.4: Cost effectiveness of reducing nitrogen

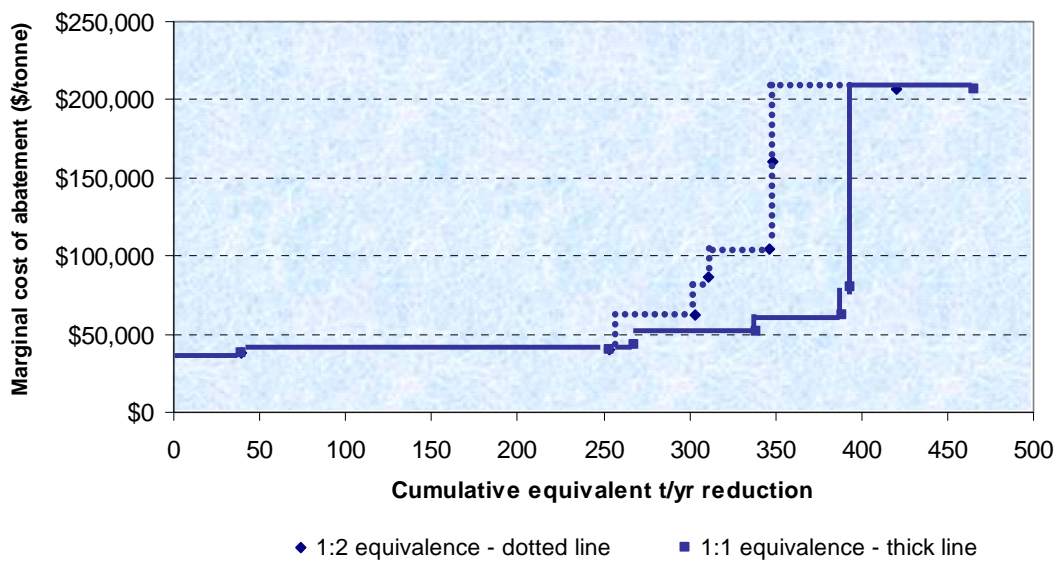


Appendix 4: Trade benefits where environmental equivalence is less than 1:1

The assessment of trade benefits in the main body of this report assumes all WWTPs have an environmental equivalence of 1:1. It is likely that the WWTPs higher in the catchment such as Oxley Creek and Fairfield would have less than a 1:1 equivalence with the other WWTPs further down as they are likely to have a lower per tonne impact on Moreton Bay. The environmental impact of discharges from Wynnum WWTP may also be lower because of the location of the discharge into Moreton Bay.

The likely abatement effort to meet the phosphorus target would change under alternative environmental equivalency relationships. For example, with equivalency for Oxley Creek, Fairfield and Wynnum WWTPs relative to the others set at 1:2, any abatement from these WWTPs would only provide half the equivalent reduction from any of the other WWTPs, and therefore greater abatement would be required overall. Any abatement at these three plants would become more expensive per tonne. Figure A4.1 shows how the marginal cost curve would shift if the environmental equivalence was 1:2.

Figure A4.1: Impact of environmental equivalence on phosphorus abatement



At the required reduction of around 400 tonnes per year, the marginal cost of abatement with the different environmental equivalence assumptions increases from \$80,000 per tonne to over \$200,000 per tonne. The target could no longer be met by only reducing phosphorus to 2 mg/L at all plants as the reductions at Oxley Creek, Fairfield and Wynnum WWTPs would be worth less and the cost-effectiveness of reductions at different plants would change. For example it would become cheaper to implement metal salt dosing at Gibson Island than at Wynnum or Oxley Creek.

Costs under the bubble would increase by around \$15m to \$33m as a result of introducing lime dosing at Luggage Point. Under a traditional regulatory approach to achieve an equivalent

target, Oxley Creek, Fairfield and Wynnum would be required to reduce phosphorus by 40 percent each (instead of 20 percent) in order to provide an equivalent environmental outcome. These three plants would need to implement lime dosing and all others would implement metal salt dosing. The costs of this would be around \$41m. The cost savings of the bubble approach would be around \$8m.

Lastly, if these plants had an environmental equivalence of greater than 1:1, the abatement effort to reach the indicative nitrogen target would be unaffected. This is because Luggage Point would still carry out all the nitrogen abatement.