CSIRO Land and Water

River Murray Dryland Corridor Revegetation Policy Options

Jeff Connor and Brett Bryan

Policy and Economic Research Unit

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Stage 1 Report for the River Murray Dryland Corridor Project

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Executive Summary

Past land clearance in the River Murray Dryland Corridor (or *Corridor*) in South Australia to enable dryland farming has resulted in the degradation of biodiversity, exacerbation of wind erosion and increased groundwater recharge which ultimately leads to increased influx of saline groundwater into the River Murray.

The South Australian Murray-Darling Basin Integrated Natural Resource Management Board (INRMB or the *Board*) has committed to targets for revegetation as a way to address biodiversity degradation and wind erosion in the dryland areas, and to reduce the impact on river salinity. To date, the primary approach to achieving this goal has involved a devolved grant scheme and cost-sharing with landholders willing to undertake revegetation.

The aim of this report is to investigate policy options to encourage cost effective large scale revegetation in the River Murray Corridor that increases biodiversity, wind erosion and salinity benefits in ways that are considered to be equitable by the community.

Objectives

The objectives of this study are to evaluate and discuss three broad policy options and how they might be applied to encouraging large scale revegetation in the Corridor, including:

1. Payments, especially with regard to tendering for revegetation contracts
2. Tradeable credit systems, especially with regard to salinity credits
3. Market barrier removal, especially with regard to developing a biomass industry

Policy Design Challenges

Past experience with similar issues suggests that there are four key policy challenges that would have to be taken into account in choosing among options and in designing any policy that is implemented. They are:

- Challenges arising from cost, administrative and political feasibility of changing policy influencing revegetation;
- Feasibility, efficacy, equity and cost of environmental performance monitoring, and developing policy that differentiates payment rates more finely than is currently the case among landholders based on spatial differences in impacts of actions to improve environmental outcomes;
- Acceptability of policies that involve uncertainty about effectiveness of actions at influencing environmental outcomes to governments;
- Limited willingness of landholders to supply environmentally beneficial revegetation options such as farm forestry that involve large upfront costs and many years until any payoff.

Evaluation of tendering policy options

- Tendering is a payment approach that involves asking landholders to submit bids describing actions they are willing to undertake and the level of payment they would be willing to accept to undertake these actions. Bids are selected for funding based on environmental cost effectiveness.
- Tendering approaches have the advantage of requiring relatively little change from current policy. They are essentially a refinement of the current cost sharing payment approach.
- Past experience shows that tendering can reduce the cost to government of encouraging environmental protection outcomes by local landholders.

- Tendering has the greatest potential to increase environmental benefit per cost sharing dollar where there is a good informational basis (data and benefits assessment methods) for comparing environmental benefit of bids.
- Established techniques and appropriate data for bid ranking and selection are available in the case of the Corridor as the result of extensive study that has already taken place.
- Conceptually, bids could be solicited from individual landholders, from collectives of landholders such as landcare groups or from larger institutional investors who might "bundle" packages of multiple offers to revegetate.
- Tendering approaches may be of limited value where highly targeted actions are desirable because the approach relies on voluntary action and this may be limited in targeted areas where actions are most environmentally effective.
- There is some emerging evidence that a cleverly designed tendering process that involves education about ecological value of cooperative action can improve ecological outcomes.

Evaluation of the biomass industry development option

- A biomass energy plant in the Corridor may well be economically attractive as a private enterprise. Recent analysis (Ward and Trengove 2004) suggests that a plant producing both electricity and activated charcoal could make a commercial rate of return on investment (15%) whilst paying farmers to revegetate at rates that are competitive with returns to current landuses.
- For a biomass industry model to be successful, it may be necessary to address cash-flow timing constraints that make perennial plantings unattractive to some landholders. One approach would be to offer contracts guaranteeing fixed annual payments to landholders for planting perennial woody species.

Evaluation of payments based on salinity credits for revegetation

- Conceptually, government subsidisation of payments to farmers to undertake biomass, or native species planting may be justified in that this could represent a less expensive way for government to attain river salinity, biodiversity, and wind erosion benefits than alternative payment policy approaches.
- A well developed technical capacity to assess salinity impacts of revegetation and dollar benefits to downstream users already exists.
- The government could make payments for revegetation that reduce the costs of future salt loads to the river.
- There is some risk due to the uncertainty surrounding the effectiveness of revegetation in reducing salt loading over time.
- Risk management could involve setting an upper bound on payments for revegetation at some fraction of the estimated cost of salinity to downstream users (e.g. 50%).
- However, recent analysis of the economics suggests that on a per hectare basis the payment that would be justified as the result of salinity damages avoided would be small relative to what a commercial biomass enterprise could pay for biomass plantings.

Where to from here?

The information provided in this report, together with the evaluation of biomass energy plant economics by Ward and Tengove (2004), and forthcoming work by Bryan *et al*. (2005) should provide the SA Government a good basis to select one or more option outlined here

for further assessment and/or development. Designed appropriately one of the above options, or a combination of policy options has the potential to encourage large scale revegetation in the River Murray Dryland Corridor.

Acknowledgements

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1. Introduction

This study is a qualitative evaluation of policy approaches to encourage revegetation in the River Murray Corridor (or *Corridor*) region in South Australia. For the purposes of this study the Corridor is defined as a strip of land delineated using a 15km buffer on each side of the 1956 River Murray floodplain from the Victorian/NSW border to Tailem Bend in the south (Figure 1). The Corridor area has been subject to large scale land clearance and whilst significant areas are under irrigated agriculture, most of the cleared area is now used for dryland cropping and grazing. It is these dryland areas that are the focus of this study. As a result of this land clearance in an era before the resultant adverse consequences were understood, the area is subject to increased recharge which ultimately leads to increased influx of saline groundwater into the River Murray channel. Land clearance, encouraged by government in a past era has also degraded the biodiversity of the area and led to wind erosion problems in many parts.

The South Australian Murray-Darling Basin Integrated Natural Resource Management Board (INRMB or the *Board*) has committed to targets for revegetation as a way to address problems with salinity, biodiversity and wind erosion in the Corridor. To date, the primary approach to achieving this goal has been a devolved grants scheme involving cost-sharing with landholders willing to undertake revegetation.

This report was commissioned to investigate policy options to encourage large scale revegetation in the River Murray Corridor in ways that increase salinity, biodiversity and wind erosion benefits. The goal is to identify approaches that could be implemented in ways that likely to be cost effective and considered to be equitable by the community.

The report is divided into four sections. Section two describes the range of instruments that can at least conceptually be applied to environmental issues in general terms and outlines briefly how each type of instrument could be specifically applied to revegetation in the River Corridor. Section three describes past experiences that are likely to be the most important challenges to cost effective, environmentally effective and equitable policy for revegetation. This section also describes how policy could be implemented to overcome key challenges that are likely given the complex historical, economic, ecological and social context of the River Murray Corridor. Section four summarises findings and concludes by recommending a range of policy options for further evaluation.

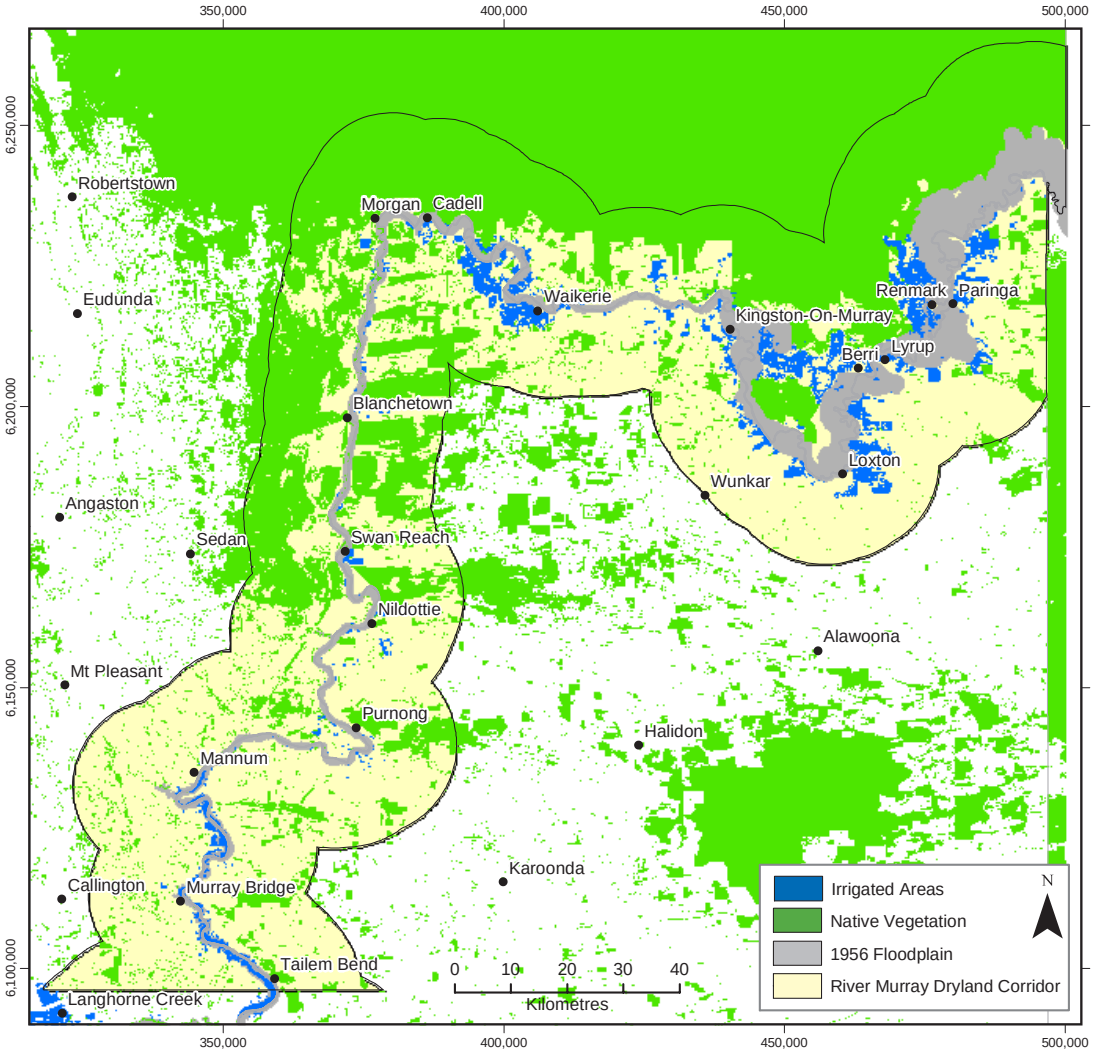


Figure 1 – Location of the River Murray Dryland Corridor study area.

2. Policy Options

2.1. A Typology of Policy Options

There are a range of policy approaches that can be and have been used to encourage actions such as revegetation with potential to improve the environment. The typology used here begins with the differentiation that economists consider to be fundamental between what is referred to as "technology-based" or "command and control" and "incentive based policy" or "market based instruments" (MBI). Technology-based policies characteristically involve a particular kind of abatement process, uniformly applied to all sources. The three main variants[1] are:

- Technology standards (e.g. requiring cement lined effluent ponds for livestock farms);
- Practice requirements (e.g. buffer strips of certain width between field crops and streams); and
- Input limits (e.g. bans on distribution of some pesticides or limits on rates and numbers of applications of others).

When referring to MBI, economists mean policies that provide some incentive to reduce environmental impact and provide some flexibility in choice of means to achieve prescribed goals. Economists (e.g. OECD, 1994, Stavins, 2000; Randall, 2003) often differentiate between three main varieties of MBI:

- **Charges or payments** on emissions, environmental performance or some proxy (inputs or practices correlated with environmental performance);

- **Tradeable credit** approaches involve establishment of requirements for credits to emit pollutants (or use inputs that are correlated with pollution), limit the number of credits available to each source, and allow sources to meet credit requirements by reducing emissions or by buying credits from other sources which create a surplus through emissions (or input) reductions.

- **Market barrier removal** approaches to create markets that can lead to improved environmental outcomes where such markets previously did not exist. It is useful to consider three distinct sub-categories:

    - **Commercial market development** approaches involve efforts to facilitate producing things in environmentally friendly ways. Production labelling schemes are one of the most discussed variants and involve labelling products produced in a way that improves the environment so that those willing to pay a premium for claimed environmental improvements can (e.g. Mech, 2004). An alternative approach to commercial market development (sometimes called industrial development policy) involves government supporting development of industries with assistance such as infrastructure development, market research or tax concessions. While the approach has typically focussed on economic developmental goals. Industrial development policy could focus on development of industries that produce in ways that generate favourable environmental outcomes;

[1] A fourth form of MBI discussed by some economists is subsidy removal (e.g. Bari, 2002). It is of little relevance here as there is very little subsidy for dryland farming in the Corridor. Certainly, if time could be reversed, subsidisation of clearing that took place in the past might be reconsidered.

- **Institutional barrier removal** approaches involve changing rules governing resource use in ways that allow those with interest who were previously precluded to act in markets to improve environmental quality. An example would be recent reforms in water law in some western US states that now allow purchase of water to be set aside for environmental flow where previously only purchase of water for consumptive use was allowed (Landry, 1998).

- **Information, risk and capital barrier removal** – Sometimes new technology or management that can improve the environment and save money are poorly understood by those who could implement them. Given uncertainty about outcomes and expensive effort required to improve certainty, risk adverse landholders with limited capital are hesitant to make such investments. Information, demonstration, financing, and innovation insurance policies can remove such barriers in some cases.

2.2. Policy Options for the River Murray Corridor

Conceptually, at least, any of the MBI policy types outlined above could be applied to encourage revegetation in the River Murray Corridor. A number of specific MBI options for the River Murray Corridor are outlined here in broad terms and elaborated on and further evaluated in the next section.

2.2.1 Payments

The current approach is a payment policy using the standard "devolved grant" cost sharing approach. Landholders receive payments at levels that are preset for agreed practices. Payment levels on a per hectare basis are differentiated across broad zones with higher rates in zones where on average greater environmental benefits are expected. Newer GIS analyses (Bryan *et al*, 2005) suggest that impact of similar actions vary considerably within zones. Thus there could be benefits to more finely differentiating payments.

Tendering is an MBI alternative to the current payment policy that could improve program cost effectiveness. The basic idea is that those sources interested in taking action to reduce environmental impact submit bids describing actions they propose and compensation they would require. The agency soliciting bids then ranks bids based on cost per unit environmental benefit expected and offers to fund the most environmentally cost effective among potential offers.

The approach has been widely applied to natural resource policy. Examples include the US Conservation Reserve Program (Smith, 2003) the Australian BushTender program (Stoneham *et al.,* 2002), and Catchment Care programs (Bryan *et al.,* 2004), the New Zealand East Coast Forestry Program (Hatton McDonald *et al*. 2004) and the Colorado River Salinity Program (U.S. Bureau of Reclamation, 2001). Tendering typically involves use of models to develop some measure of expected environmental impact estimated with parameters characterising proposed actions and attributes of sites where actions are proposed.

Economic theory suggests that tendering should be an attractive form of payment policy from a government perspective for two reasons:

- If properly structured, a tendering policy can provide sources with incentives to reveal something close to the minimum amount that they would require to provide actions. In contrast with the current devolved grant approach, all are funded at the same rate,

including those who would gladly offer the works for less. In addition, tendering could induce action from some who might only offer works with very high environmental benefits by accepting bids at rates higher than the current level in some cases.

- When underpinned with good biophysical modelling, tendering approaches offer an informational basis for prioritising bids based on environmental impact per dollar spent.

Several ex-post evaluations of Australian tendering programs dealing with diffuse terrestrial biodiversity and water quality issues concluded that such approaches can be cost effective in comparison to uniformly set payments (Stoneham *et al.,* 2002; Bryan *et al.*, 2004). The operation and results of the Bush Tender program are explained in Box 1.

Box 1: The Victorian BushTender Program

BushTender is an incentive based approach to encouraging private land management practices that will protect and enhance remnant native vegetation. The program was first trialled at two pilot sites in Victoria in 2001 (DNRE, 2001). Participants, working with program officers, prepare plans describing actions they are willing to take to enhance biodiversity on their property. After preparing plans potential participants submit sealed bids stating the cost-share payment they would be willing to accept to carry out the plans. The DNRE then sort the bids on the basis of cost per unit of ecological value. The result is a bar graph of offers ordered by the incentive payment requested per unit of ecological value. The DNRE then accepts cost sharing offers in order of value of ecological benefits per cost-sharing dollar until the program budget is exhausted.

Evaluation of the first year of program experience led to the conclusion that significant numbers of program participants offered to undertake high levels of on ground works for small incentive payments. It was estimated that about 25% more environmental benefit was achieved as the result of giving out $400,000 of incentive money through tendering than would have been achieved had cost sharing been offered at a set cost sharing rate (Stoneham *et al*., 2002).

In the past, most tendering approaches have involved soliciting offers form small individual landholders to change land management. Examples of this approach include BushTender (Stoneham, *et al.,* 2002), the US Conservation Reserve Program (Smith, 2003), and Catchment Care (Bryan *et al.,* 2004). In principle, tenders could also be solicited for large proposals involving collective action by multiple parties and/or offers to change land management practices over large areas as part of an investment that involves development of a woody perennial industry or some approach to capturing amenity values associated with revegetation (e.g. eco-tourism). For example, the South Australian government could solicit bids form large institutional investors or landholders collectives with evaluation of bids based on collective cross property environmental outcomes. This would be conceptually similar to the way the government currently solicits bids for large bundles of goods like computers or cars. The potential merits of such an approach are discussed in the evaluation of tendering policy approaches below.

2.2.2 Tradable Credits

Under current MDBC salinity policy, the South Australian Government has obligations to offset any increases in salinity concentration in the River Murray above 2001 levels that originate in SA (MDBMC, 2002). This MDBC salinity accountability involves debits for all actions that increase river salinity and credits for all actions that decrease river salinity (relative to the 2001 baseline). As the protocols detailing implementation of this policy currently stand, credits that result from private actions such as revegetation that reduce salinity are granted to States not the individuals taking the actions. Consequently, current salinity policy implementation provides no incentive for private parties to take actions such as revegetation that decrease river salinity loading.

Currently, South Australia meets its River Murray salinity obligations primarily through salt interception of saline groundwater. Economic opportunities for salt interception schemes are identified by comparison with known costs of salinity to downstream users in dollars per unit of Electrical Conductivity (EC) at various points along the River Murray. The opportunities for economic salt interception schemes are limited. An opportunity exists to reduce the cost to the South Australian Government of meeting its MDBC salinity obligations by modifying treatment of salinity credits for actions by landholders such as revegetation that reduces groundwater recharge and hence, river salinity.

One approach could be along the lines of "opt-in" provisions in US SO^2 and point/diffuse source nutrient credit trade programs. In both programs some sources place caps on emissions: large coal fired electricity plants in the SO^2 case and large point sources of nutrients such as factories or water treatment plants in the nutrient credit trade case. Other smaller sources, for example farms in the nutrient credit trade case and smaller factories in the SO^2 case, face no caps on emissions. However, such sources can "opt in". This involves voluntarily establishing a baseline level of emissions and receiving credits for reductions in emissions below their baseline that can be sold to those facing mandatory caps with demand for extra credits (Schary, 2003). The approach creates an incentive for "uncapped" sources to offer emission reductions when they can do so at lower cost than those facing mandatory emissions caps (Schary, 2003).

Applied to revegetation and salinity in the Corridor, an "opt in" approach would allow States such as SA that require credits to meet their MDBC obligations to enter into agreements for provision of credits with landholders who can reduce salt load to the River through revegetation. The policy could be implemented so that revegetation efforts were only funded when they are expected to provide salinity credits for less than the cost of the equivalent salinity to downstream users. This is the same way that decisions to provide salt interception schemes are made.

2.2.3 Market Barrier Removal

Commercial market development may be an attractive approach to encouraging revegetation in the Corridor. The basic idea would be to offer some form of Government support to develop an industry that uses biomass from woody perennial plantings as an input, thereby increasing the demand for revegetation. An example is the Narrogin energy plant in Western Australia. The plant contracts local farms to establish trees and provides for their harvest. The trees are then used to produce both energy and activated charcoal. It is possible that a South Australian Government financial contribution to a commercial market development strategy could be justified even for an industry that was not profitable enough to attract unsubsidised private investment.

In particular, this could be the case if development policy were viewed as an alternative to a payment policy and the Government contribution were less on per unit of river salinity load reduction, wind erosion control, biodiversity improvement basis than alternative payment policy options. Recent economic analysis summarised in Box 2 suggests that this option may be commercially viable.

Box 2: The economics of biomass energy in River Murray

The idea of a biomass enterprise would be to contract farmers to plant trees to fuel an energy plant. An enterprise along these lines known as the Narrogin biomass energy scheme is currently being constructed in Western Australia and farmers have already been contracted to plant trees to fuel the plant. The intent of the Narrogin scheme is to produce multiple outputs, not only energy but also activated charcoal and eucalyptus oil, as economic analysis suggested that the Narrogin plant may not be as profitable with energy as the sole product.

Ward and Trengove (2004) have assessed the economics of developing a biomass energy enterprise in the River Murray Corridor. One key conclusion of their analysis was that, as with the Narrogin plant in Western Australia, production of multiple outputs (energy plus activated charcoal) would be necessary for a biomass plant to be profitable in the Corridor.

Another key conclusion was that the amount a plant could afford to pay landholders per hectare of biomass (net of production, harvest and transport costs) and still make a commercial return would vary by location of planting. This is because of location differences in productivity related to rainfall, transport and harvest costs. Payments that a plant could afford if 15% of annual return on investment were required were analysed for plantings in three part of the Corridor Zone 1 refers to the reach from the Victorian border to Lock 3. Zone 2 refers to the reach from Lock 3 to Morgan and Zone 3 from Morgan to Wellington. The highest level of payment per hectare is estimated in Zone 3 where a plant could pay approximately $45 per hectare per annum to landholders for planting biomass net of all costs and still make a 15% return on investment.

In addition, biomass planting may have natural resource management benefits of reducing salinity loading in the River Murray and wind erosion. Ward and Trengove (2004) and Bryan *et al.* (2005) estimated the recharge control that would result in a scenario involving 14,000 ha of revegetation distributed across zones scenario could reduce River salinity concentration by around 4 EC at Morgan within 100 years. Because most of the benefit occur several decades after planting the discounted value of benefit is very small on per hectare of biomass planted basis. Ward and Trengove (2004) and Bryan *et al.* (2005) conclude that given the low levels of estimated salinity reduction benefit, the costs of a salinity reduction payment policy design and implementation are likely to exceed the public benefits.

3. Policy Challenges and Design Answers

The situation in the Corridor conforms to the class of environmental issues that involve environmental impacts from many diffuse sources. Four key challenges to successfully implementing cost effective, equitable policy for diffuse source environmental issues have been identified in the literature evaluating the issue. The challenges are:

- Property rights arrangements;
- Environmental performance monitoring and differentiation feasibility, efficacy and cost;
- Risk assignment with uncertainty about efficacy of control;
- Information, capital, management, time preference and behavioural/social constraints on the willingness to supply environmental action.

These challenges are described in generic terms and their implications for Corridor revegetation policy are discussed in this section. In addition, details of policy design that might be effective at addressing key challenges to effective, efficient and equitable for River Corridor revegetation policy options outlined above are discussed.

The discussion is premised on the assumption that what makes one policy approach more effective at addressing a particular challenge than another is not simply the type of instrument employed (e.g. tradeable permits, charges) but the detail of policy design. The discussion draws on analyses found in the literature that focuses on how one policy viewed as a bundle of design attributes might be more likely than another to overcome particular impediments (Randall, 2003; Schary, 2003; Stavins, 2000; Connor *et al*, forthcoming). In this discussion, the policy choice problem is viewed as a matter of selecting from a menu of potential options and policy design features that are best suited to address the most relevant challenges in a given context. The goal is to consider how particular MBI options can be crafted to address the particular challenges identified for River Corridor revegetation. In discussing policy design features the following categories of policy design are considered:

- Policy basis – Options include charges, payments, credits based on environmental outcome, measured emissions, inputs, practices, observable attributes used to model outcome or emission.

- Differentiation – Options include charges, payments, credit requirements on a uniform basis for all sources, spatially differentiated, differentiated by price discriminating auction, temporally differentiated, differentiated based on input use, emissions or impact level (e.g. tiered pricing).

- Timing – Options include payment, charge or credit assignment at time of action, at time of impact, using bonding, or deposit refund approaches, alternative finance arrangements to address cash flow constraints, credit trade with or without banking and borrowing.

- Targeting – Options include policy treating all sources, policy treating only a limited number of large sources that cumulatively represent most of impact, choosing sources for treatment through price discriminating auction.

- Transaction requirements – Options include responsibilities for sources to investigate and monitor, or for agencies to investigate and monitor; charges, payments or credit requirements based on pre-authorised terms or on individual transaction monitoring and modelling.

3.1. Property Rights Arrangements

3.1.1 Challenges

One useful way to think about the challenge of devising cost effective environmental policy involves considering the policy as a social contract specifying benefits accruing to and obligation required of those granted access to a resource. Economist such as Bromley (1991) refer to contracts specifying bundles of rights and obligations as property rights. For example if you own residentially zoned land your property rights probably include obligations to pay council rates, a right to resell the property, and an obligation not to convert the land to commercial development.

Often obligations related to environmental management are not specified or not enforced. So, for example, recharge rights are not completely specified in that there is no legislated obligation for landholders in the Corridor to achieve a particular level of recharge.

The kinds of property rights that are or are not in place in a given setting can be a major determinant of what policy options are feasible. For example, the absence of obligations for polluters to limit emissions represents a fundamental impediment to tradeable credit policies (Randall, 1978). Similarly, lack of administrative apparatus for enforcement of obligations can limit the range of policy that can be implemented in some settings.

Conceptually, property rights impediments to policy can be overcome by establishing additional property rights. For example, at least conceptually, a legal obligation not to exceed a set level of recharge per hectare could be legislated. However, specification of property rights in a way that would allow markets to function is not necessarily desirable when all costs associated with development and ongoing operation of alternative property rights arrangements are accounted for. A fundamental finding by Coase (1960) is that in some situations the costs of developing, administering, and enforcing property rights may exceed the value of efficiency gains possible with changed property rights arrangements. For example, given the challenges in actually measuring or estimating recharge, the cost of a monitoring, administration, and enforcement system to do so would very likely exceed the value of benefits that could be expected as a result.

Another type of challenge to changing property rights arrangements even when this may be cost effective accounting for all cost and benefits to society (including costs of developing and implementing alternative property rights arrangements) might be referred to as an equity impediment or challenge. Such impediments have to do with the political feasibility of some property rights arrangements that involve increased cost for some parties even though the design is potentially more efficient for society as whole. So, for example, although it could be the case that shifting from a sharing policy that paid all landholders to revegetate to policy that involved charges based on estimated impact of recharge would be more cost effective for society as whole, it would involve a significant shift in responsibility and compliance costs and thus may not be politically feasible.

3.1.2 Implications for Revegetation Policy in the Corridor

Currently there are few legislated obligations requiring landholders in cleared areas of the river Corridor to limit recharge or to compensate those who are impacted as the result of Mallee clearance[2]. Indeed, clearing land was a legislated requirement to gain land title at the time the land was settled. Many landholders in the area recognise the adverse consequences that land clearing has had and certainly strive to farm in ways that ameliorate adverse impacts of land clearing that took place in a past era. None-the-less, the lack of legislated obligations means that tradeable credit and environmental charge policies would

[2] In contrast, holders of land that supports native vegetation have clearly defined and enforced obligations not to clear under the Native Vegetation Act, 1991.

not be feasible in the study area unless property rights defining such obligations were developed as legally enforceable obligations. Considering that much of the impact of clearing is the result of decisions taken in the distant past, it also seems likely that charges or obligations to reduce recharge that involved significant compliance costs for landholders would be politically infeasible.

Payment approaches are generally feasible within current property rights constructs and in fact represent the status quo policy. There may well be ways to re-organise the design features of the current payment approach to increase cost effectiveness, for example by changing to a tendering system, as discussed in the last section.

The option of re-arranging how the Government of South Australia deals with meeting its MDBC salinity impact mitigation responsibilities discussed in the last section would also require some re-arrangement of property rights. As already discussed, under current MDBC protocols, salinity debits and credits resulting from private commercial actions such as revegetation are attributed to States (MDBC, 2003). Thus while there are some non-financial incentives (e.g. community recognition, environmental ethics) there are few financial incentives for landholders to contribute to the solution, even if they can do so at low cost. The potential for an “opt-in” approach was described in the last section. The approach is likely to be considerably less challenging from a political feasibility perspective than approaches requiring development of mandatory obligations to reduce recharge. In essence, the “opt-in” approach is a “self selection” targeting strategy that allows those who can most cost effectively contribute to select themselves as program participants. One important advantage of this type of targeting is that developing credit/debit registers, performance auditing would only be necessary for a perhaps relatively small number of landholders who would “opt-in” and the considerable expense involved in such effort could be avoided for the potentially large number of landholders who might not participate.

3.2. Monitoring and Differentiation

3.2.1 Challenges

Actual environmental performance can often be measured for point source environmental issues. For example, levels of air or water pollution emitted from a factory pipe can often be directly monitored at reasonable cost with available technology. In contrast, monitoring the actual environmental outcome of interest is often a challenge with diffuse source environmental issues. A result has been that many diffuse source environmental issue policies have focused on a narrowly described set of practices or inputs. This has precluded the kinds of savings from response flexibility that have made point source MBI, that were focussed on actual performance, so cost effective (Randall, 2003; Schary, 2003).

The only real alternative to basing policy on actual environmental outcome in many cases is to base policy on inputs or practice that can be readily observed (e.g. level of revegetation and perhaps quality of revegetation in the river Corridor case). However, to realise cost savings with MBI approaches in settings where actual outcome monitoring is not possible, someway to account for differences in the way similar input levels can lead to very different impacts is necessary. Economists have long understood that where impact of an identical amount of input or practice varies spatially, as is often the case with environmental quality issues, uniform charges, payments or credit requirements based on input or practice will not be cost effective (Tietenberg, 1978). The reason is that if resources are spent to reduce input where little environmental impact results, more impact could have resulted if the same level of resources had been spent at locations where greater impact would have resulted from the same level of input or practice change.

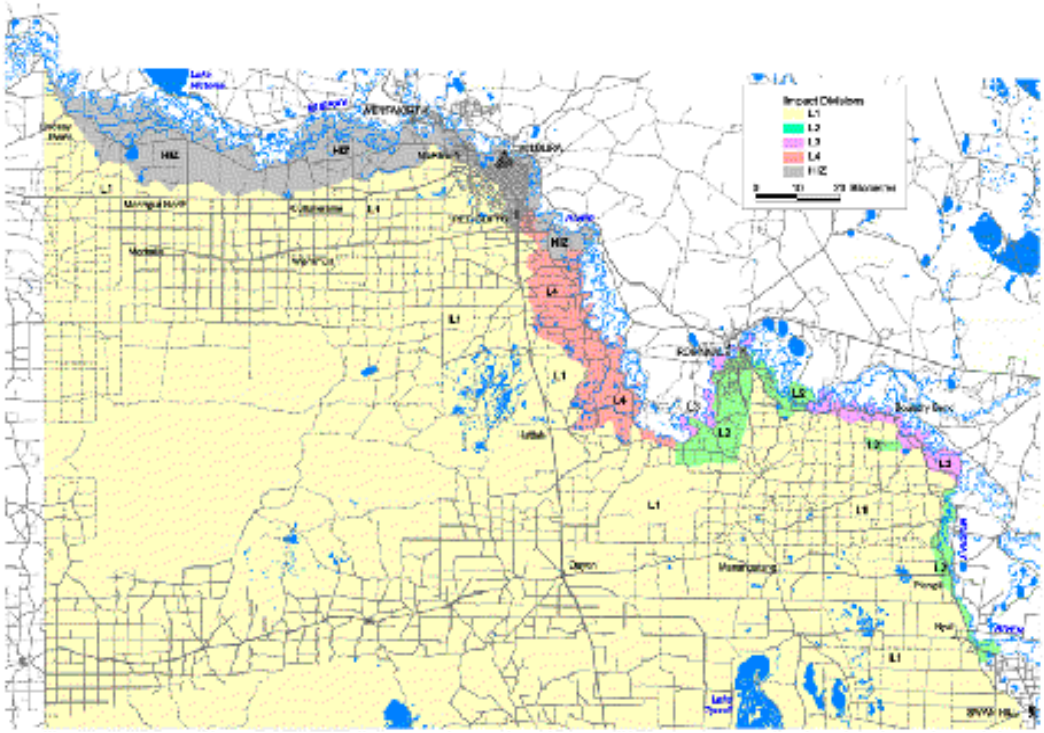
Early proposals in the economics literature suggested individually differentiating credit requirements, charge or payment rates to reflect differences in impact per unit of action (Tietenberg, 1978, Rose-Ackerman, 1973). A challenge arises because individual differentiation may be politically infeasible and policy involving complex differentiation based on individual case modelling may introduce very high transactions costs (Baumol and Oates, 1988). The result is that there are tradeoffs between potential cost-effectiveness gains from policies that allow more perfect differentiation and resultant transaction costs[3]. Potentially, there may also be equity issues related to differentiation, in that some kinds of differentiation may be considered inequitable.

One way to capture some of the advantages of a policy based on actual performance when performance cannot actually be measured, without the high transaction costs of site specific data gathering and modelling for each transaction, is zone based charge, payment or credit requirement differentiation. Tietenberg (1978) was an early proponent of this approach. The Nyah to the South Australian Border Salinity Management Strategy is a good example of a policy for a diffuse source environmental issue using this approach. As explained in Box 3, charge rates for salinity impact in this scheme are on based on water use with different rates in each of four zones based on estimated differences in zone average salinity load impact of drainage.

[3] For example, the U.S. SO^2 credits program has provision for credit trade both within and among bubbles. Bubbles are local areas where impact per unit emissions from all sources has roughly equal environmental impact. However, trade outside of bubbles requires modelling of impact for approval and to set terms of trades. Stavins (2001) suggests that costs associated with assessing impacts of trades outside of bubbles might be an explanation of why very few trades out of bubbles took place.

Box 3 - Zone based charges for irrigation salinity impacts in Victoria

The Nyah to the South Australian Border Salinity Management Plan has been in place in the Victorian Sunraysia Irrigation Trust since 1993 (Sunraysia Rural Water Authority 2002). The policy involves a levy for irrigation development proportional to the salinity impact that the irrigation causes. Proceeds finance salt interception. The area under the plan has been classified into five zones, as shown below based on hydrogeology modelling of salinity impacts of irrigation.



The grey shaded area denoted HIZ in the figure above is designated high impact zone. No new irrigation development is allowed in this area because, in the judgement of plan administrators, salinity impacts of irrigation in this area are so high that they would result in very rapid depletion of the limited supply of salinity mitigation capacity in the region.

In the four low impact zones (L1-L4), irrigation development is allowed. However, in addition to other conditions, salinity charges are levied. The charges are proportional to modelled average salinity impact of irrigation in each zone as shown below. The levy can be paid on a once off basis or as ten annual payments.

3.2.2 Implications for Revegetation Policy in the Corridor

Ultimately, the outcomes of interest in the River Murray Corridor are not revegetation *per se*, but rather reductions in salinity, and wind erosion and enhancement of biodiversity. Clearly, it would be difficult to implement policy on the basis of these outcomes because they would be difficult to monitor. There are large time delays (decades) between action (revegetation) and impact (reduced salt load, increased biodiversity) and the process of salinity loading takes place below the surface of the land where it cannot be directly observed.

Conceptually, zone based payment differentiation with higher rates where benefits are greater would be a way to capture some of the benefits of differentiation in setting payment

levels to encourage revegetation in the River Corridor. As discussed above tendering is one way to structure a payment policy to capture benefits of differentiation.

Clearly, an important prerequisite to using modelled impacts as a policy base for approaches such as tendering or to a lesser extent zone based payment for charge differentiation is good data availability for relevant parameters and a good understanding of and capacity to model relevant environmental processes. When such capacity does not exist, there is need to carefully consider how the costs of developing such capacity compare to the benefits of policies that can be implemented with such information. Fortunately, in the case of the River Murray Corridor, considerable investment has already been made that provides a good basis for prioritisation of actions based on scientific information about both salinity and biodiversity benefits. More detailed description of this capacity and how it can be used in prioritisation will be forthcoming in the Stage 2 project report.

3.3. Risk Assignment with Uncertainty about Efficacy of Control

3.3.1 Challenges

As explained in the property rights discussion above, environmental policy can be viewed as a contract between those with access to a resource and society as whole that defines a bundle of obligations and rights associated with use of the resource. The goal of most environmental policy is to achieve some state of the environment (e.g. river salinity below a certain concentration). However, there is nearly always some uncertainty regarding what the actual contribution of specific actions toward meeting the goal are likely to be. All environmental policy assigns responsibility to deal with consequences of outcome uncertainty.

Often the responsibility to deal with consequences of uncertainty is implicitly assigned to society (rather than individuals with access to resources). The current cost sharing approach to encouraging revegetation in the Corridor is an example of a property rights arrangement assigning consequences of uncertainty to society. Payment is given for action (e.g. revegetation) rather than performance (e.g. salinity load avoided). There are no contingencies for withholding part of payment if revegetation establishment is unsuccessful or avoided salinity impact turns out to be less than anticipated when understanding of environmental processes is improved.

Some environmental policy assigns responsibility to deal with consequences of uncertainty to parties using resources in ways that impact the environment. A good example is the MDBC salinity agreements between the States along the River Murray. Under this agreement, states are responsible for taking actions necessary to mitigate any increases in river salinity above defined baseline levels. Several provisions assign responsibility for risks related to outcome uncertainty of mitigation actions. One provision is that credits are only granted to State governments for actions once they are proven to be operating effectively. Other provisions allow for States debit positions to be updated in some instances based on improvements in the scientific basis for estimating impacts (MDBC, 2003).

Clearly, applying more complex contingencies such as those in the MDBC salinity agreements to landholders would reduce risks to society resulting from uncertainty regarding outcomes of actions. However, developing and implementing the necessary property rights arrangements would result in greater administrative, monitoring, negotiation, and enforcement effort than less complex property rights arrangements, such as simple contracts to take specified actions, that implicitly assign risk to society.

Ultimately, treatment of risk involves tradeoffs between the governments' willingness to bear risk, and the costs of measures to deal with risk such as administering property rights arrangements with more complex contingencies. Generally, more complex arrangements

would be unlikely to be cost effective when dealing with many small diffuse sources for an environmental externality. This is because the level of costs associated with administering, monitoring, and negotiating complex agreements would tend to be very large compared to benefits for contracts with many small sources as opposed to a few large sources.

An approach known as “trading ratios” has been used in many U.S. point source / diffuse source nutrient credit trade policies as a way to lower Government risk without increasing costs of administering, monitoring, negotiating contracts (Schary, 2003). The basic idea is that point sources with mandatory requirements to meet set emissions levels or attain credits from other sources through trade, can enter into agreements with diffuse sources. Diffuse sources can supply credits by implementing agreed practices to reduce nutrient loading. To account for the greater uncertainty associated with diffuse sources, source credits can only be used to offset point source debits at a trading ratio. Typically trading ratios are 2:1 or 3:1, meaning that twice or three times the estimated diffuse source load reduction is required per unit point source reduction. A conceptually similar approach could also be applied to payment policy (e.g. half the payment per unit estimated environmental improvement for more uncertain actions). The essence of the concept has also been applied to tendering. In the Colorado River Salinity Program (U.S. Bureau of Reclamation, 2001) bids for actions to reduce river salinity loading with greater outcome uncertainty are rated less highly (all other things equal) than bids for actions with less outcome uncertainty.

3.3.2 Implications for Revegetation Policy in the Corridor

One of the challenges the INRMB faces with the current cost sharing approach arises because payments are on action (e.g. hectares planted). This means that the incentive is to plant but there is not necessarily any incentive to maintain planting in ways that minimise recharge. However, recharge reduction performance depends not only on what is planted (e.g. perennial pasture) but also on how well it is maintained (e.g. percentage of area cover successfully established after 1, 2, 3, 4 years). Currently any risk that revegetation is not as successful as anticipated is borne by the INRMB with no further payments in future years related to success at maintaining the effectiveness of plantings at reducing recharge.

An alternative treatment of this kind of risk that might be considered for the Corridor is under development and to be trialled shortly through a commonwealth MBI trial dealing with revegetation in the Loddon Catchment in Victoria (Ward and Connor, 2004). The idea is to partially shift risk to landholders in a way that rewards management that increases recharge reduction effectiveness by making part of payment proportional to cover measured at set times in years after establishment.

Risk assignment will also be important in considering any policy to create incentive for revegetation through changes in the way MDBC salinity credits are treated. As outlined above, under the MDBC salinity agreement between States, the South Australian Government is responsible for meeting targets of no increase in contribution to River Murray salinity above baseline levels from actions in the South Australia. At the present the SA Government primarily meets its obligations through investments in salt interception/drainage disposal. Evaluation by Connor, Cook and Miles (2003), suggest that there may be some cleared dryland farming areas in the Corridor where reductions in salt load through revegetation might be less costly than investment in salt interception as a way to meet SA MDBC salinity targets.

However, from the perspective of the SA Government, credits from revegetation involve greater uncertainty than credits from salt interception. Salt interception can be installed when salt load is already hitting the River and, based on past experience, there is good reason to expect that it will function to effectively remove most of the salt in short time (a year or two after salt interception plant installation). The result is that the SA government can be reasonably certain about the level and timing of salinity credits it can expect if it invests in salt interception now. In contrast, if the SA Government invested in revegetation (or contracts

landholders to) the timing and magnitude of salinity credits that it could expect as result would be subject to considerable uncertainty.

Studies (e.g. GHD, 1999) have quantified the cost of salinity in the River Murray to downstream users. These estimates are used to identify cost effective salt interception opportunities. Basically, if the cost of salt interception is lower (by a multiplier) than the cost of the equivalent salinity impacts on downstream users then the scheme is considered economical. However, the interception of saline groundwater intrusion onto the River Murray is most effective in particular locations along the river with the right geological and hydrological conditions. As salt interception schemes expand, opportunities for economic salt interception become fewer.

Any policy to encourage revegetation as a less costly way for the South Australian Government to meet its MDBC salinity target would require a way of treating uncertainty that is acceptable to the Government of South Australia. One administratively low cost way to treat the uncertainty issue would involve setting an upper bound on Government willingness to pay for revegetation based on the cost of salinity impacts to downstream users. In recognition that revegetation in an investment with uncertainty surrounding the impact on salinity reductions, the government could use something similar to a trading ratio approach. For example this could involve setting an upper bound on payments for revegetation at say 50% of the cost of salinity impacts to downstream users (or some other fraction).

3.4. Information, Capital, Management, Time Preference and Behavioural/Social Constraints on the Supply Side

3.4.1 Challenges

The simplest models of economic behaviour are premised on the assumption that if an alternative to current land management practices exist that is profitable, landholders will adopt it. In reality, there are a range of reasons why potentially profitable alternatives are sometimes not widely adopted. Two related constraints are: financial capital availability and time preference constraints. These can be most easily understood by considering perennial revegetation options (e.g. tree crops) that require significant investment “up-front” for returns expected many years in the future. Financial capital availability is one factor that can constrain capacity of some landholders to make such investments. The point is that there are some landholders who do not have the upfront capital requirement and cannot qualify to borrow it regardless of how profitable the investment might be. Time preferences for money is another factor that can sometimes limit adoption of land management options with long time delay until payoff. The constraint arises because some landholders facing needs to achieve economic returns on an annual basis to meet household needs prefer less profitable land uses that payoff sooner to more profitable investments with longer times until payoff.

Information represents another often significant constraint to landholder willingness to change management. While more profitable options than current practice may exist that are understood by those with specialised knowledge, this may not be understood my most landholders without specialised knowledge. Information can constrain the amount of adoption in two ways. Often understanding how to cost effectively adopt a new land management approach requires investment in information. A related informational impediment to adoption of new practices arises when a lack of understanding of how to implement new practices, increases return risk (or even just perceived risk). The cost of such information constraints must obviously be factored into their cost-benefit calculus and implies less supply of the land management practice than would be anticipated in the absence of information costs.

In general, capital, and information constraints tend to be more significant for smaller enterprises than for larger enterprises with capital investment budgets and the economies of scale necessary to justify investment in specialists with capacity to accurately assess alternative management options.

This constraint can sometimes be overcome where there are contractors who specialise in consulting small enterprises on how to change practice in ways that can reduce costs and risk. Specialist farm management consultants represent an example. In some cases, large entities will enter into agreements with smaller enterprise in ways that overcome small enterprise capital, time preference and information constraints. Forestry firms that enter into contract with farmers to plant trees are an example. These contracts typically guarantee farmers fixed annual payments on terms that forestry firms expect to be profitable. The forestry firms are willing to provide upfront capital and accept that payoff will only be realised at harvest.

3.4.2 Implications for Revegetation Policy in the Corridor

Available data on size of landholding in the river Corridor suggests a skewed distribution with a large number of small landholding and a few large ones. Information, capital and time preference constraints would likely be particularly significant for tendering applied to individual land holders. The Government could overcome this constraint by itself offering contracts along the lines that forestry firms do with evenly spread annual payments. However, both the options of tenders from larger institutions and biomass industry support could be more attractive to the Government because both approaches could be structured to require less capital and lower risk to the Government. This would be the case if support for a private entity to undertake either approach was contingent on some willingness to provide capital and accept time delayed returns.

4. Summary and Conclusions

This report evaluated four policy options to induce large scale revegetation in the River Murray Corridor in ways that increase salinity, biodiversity and wind erosion benefits, are cost effective and are considered to be equitable by the community:

- Landholder tendering involves landholders submitting bids describing type and location of revegetation they would be willing to provide and compensation they would require to provide it. Bids are then prioritised based on total environmental value per dollar.
- While in the past most tendering programs have focused on individual, often small landholders. It would be possible to implement investor tendering where bids could potentially involve a broad range of arrangements such as subcontracting with landholders, revolving funds used to buy, improve and resell property with covenants to protect environmental improvement investments, or in other investments involving revegetation. Bids again would be evaluated based on salinity and biodiversity, and wind erosion benefits and those offering best environmental value for money.
- A carefully structured policy to offset landholder costs of revegetation through payments that could allow SA to cost effectively meet its MDBC salinity targets.
- Policies to encourage development of biomass industries that use biomass from woody perennial plantings as an input, thereby increasing the demand for revegetation. Even if the approach were not quite profitable enough to attract unsubsidised private investment, it could be justified if it represented a less expensive way to attain river salinity, biodiversity, wind erosion benefits than alternative payment policy approaches.

Four key areas of challenge in implementing a policy were identified:

- The challenges that arise as the result of cost, administrative and political feasibility of changing institutional rules influencing revegetation;

- Challenges in developing feasible, effective and low cost environmental performance monitoring and differentiation;
- Challenges in finding ways to implement cost saving policy with acceptable risk to government and landholder given the uncertainty about cost and environmental effectiveness of revegetation;
- Limitations on the willingness of landholders to supply environmentally beneficial revegetation arising from information, capital, management, time preference and behavioural/social constraints.

4.1. Evaluation of Tendering Policy Options

Tendering approaches applied to either individual landholders or larger investors have the advantage of requiring little institutional change. In essence they are payment approaches just as the current policy is. The difference is the criteria by which funds are allocated - offers are prioritised based on environmental cost effectiveness.

Past experience shows that tendering can be cost effective. If properly structured the approach creates incentives for landholders to reveal something close to the minimum amount that they would require to provide actions. In contrast with the current devolved grant approach, all are funded at the same rate across broad zones. It is possible that within zones where current payments are equal some would gladly offer the works for less. In addition, tendering could induce action from some who might only offer works with very high environmental benefits by accepting bids at rates higher than the current level.

A key prerequisite to realising cost savings with tendering is good biophysical data and modelling as an informational basis for differentiating and prioritising bids. Fortunately, in the case of the River Murray Corridor, considerable investment has already been made that provides a good basis for prioritisation of actions based on scientific information about both salinity and biodiversity benefits.

Capital, time preference and information constraints would likely be more significant for a tendering policy focussed on individual smaller enterprises rather than larger institutional investors. This is because larger institutions are more likely to have capital investment budgets and the economies of scale necessary to justify investment in specialists with capacity to accurately assess alternative management options.

If the Government were to consider tendering at an individual landholder scale it might be possible to overcome capital and information constraints by offering contracts along the lines that forestry firms do with evenly spread annual payments. Alternatively, Government could tender for offers from larger institutions with bid selection based on criteria favouring approaches that offer landholders evenly spread payment to overcome capital and information constraints. This might be more attractive to the Government than managing such arrangement on its own as it would require less capital and also “outsource” specialised expertise in developing appropriate finance arrangements.

Another advantage of tendering directed at larger investors is that this approach could involve criteria for selecting bids that provide cross property environmental benefits such as wildlife Corridor connectivity. It may also encourage revegetation actions that are only profitable if implemented on large scales such as tree plantings to fuel a biomass energy plant.

Tendering approaches may be of limited value where highly targeted actions are desirable because the approach relies on voluntary action and this may be limited in targeted areas where actions are most environmentally effective.

4.2. Evaluation of the Biomass Industry Development Option

Recent evaluation by Ward and Tengove (2004) suggests that establishing a Biomass energy plant in the Corridor could offer close to but not quite adequate returns to be viable as a purely private investment. Preliminary evaluation suggests that South Australian Government financial contribution sufficient to make a biomass energy plant privately profitable may be justified in that it could represent a less expensive way to attain river salinity, biodiversity, wind erosion benefits than alternative payment policy approaches.

For a biomass industry model to be successful, cash flow timing constraints that make perennial plantings unattractive to landholders would have to be addressed. Contracts of the type that forestry firms typically offer guaranteeing fixed annual payments could be a solution. This would require provision of upfront capital by either the SA government or a private contractor running a biomass energy plant and acceptance by the party(ies) providing the finance that payoff will only be realised once harvest and plant operation begins.

4.3. Evaluation of Payments Based on Salinity Credits for Revegetation

Revegetation in the Corridor can reduce salt loading to the River. Conceptually this can reduce the need for the South Australian Government to invest in salt interception as a way to meet MDBC salinity targets. The South Australian government currently contracts with a private contractor (SA Water) to provide salt interception as a way to meet State MDBC salinity targets. In principle, SA could also enter into agreements with landholders or other contractors to provide revegetation as a way to meet salinity targets.

Using the well developed technical capacity available to it to assess the cost of salinity impacts, the Government could set rates they would be willing to pay for revegetation so that revegetation could cost effectively contribute toward meeting MDBC salinity targets. Payments for salinity credits may be made based on the cost of salinity to downstream users.

A challenge arises with this option in dealing with risk because certainty about the effectiveness of revegetation at reducing salt loading is low. One administratively low cost way to treat the uncertainty issue could involve setting an upper bound on payments for revegetation at some fraction (trading ratio) of estimated cost of salinity to downstream users (e.g. 50%).

4.4. Where to from here?

The information provided in this report, together with the evaluation of biomass energy plant economics by Ward and Trengove (2004), and the Stage 2 report by Bryan *et al*. (2005) should provide the SA Government a good basis to select one or more option outlined here for further assessment and/or development. Designed appropriately one of the above options, or a combination of policy options may have the potential to encourage large scale revegetation in the River Murray Dryland Corridor.

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