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NUTRIENT TRADING: A VIABLE SOLUTION TO WATER QUALITY
MANAGEMENT IN SELWYN DISTRICT?

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submitted in partial fulfilment
of the requirements for the Degree of
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By

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Abstract of a dissertation submitted in partial fulfillment of the
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Water quality is quickly becoming one of the most pressing environmental issues the world over. While historically New Zealand has enjoyed a relatively high quality of water, recent intensification of land use has resulted in its steady decline. This decline is highlighted perhaps no where better than in Selwyn District where all but the mountain rivers exceeded guideline values for nutrient enrichment.

This observed state highlights the failure of the current regularity approach to successfully manage the tradeoffs between economic development and ecological conservation. Nutrient Trading Programs are an innovative approach to water quality management with a demonstrated ability to successfully manage these tradeoffs. Despite examples of its effectiveness in a number of applications throughout the world, Nutrient Trading Programs are not suitable in all circumstances.

This dissertation evaluates the viability of a Nutrient Trading Program as an effective water quality management tool in the Selwyn District. Drawing from a range of evaluation studies, it develops a framework of four parameters through which this viability can be determined. Applying this framework to Selwyn District it highlights the current state of these determinant variables in the district and assess their likely impact on the success of a Nutrient Trading Program.

Overall this analysis highlights a strong suitability of a Nutrient Trading Program in Selwyn District. Legal, economic and social conditions all appear to be favourable. While the biophysical and political conditions of the district highlight some potential challenges, it is reasonable to believe that they can be effectively addressed prior to a Nutrient Trading Programs implementation. Recommendations are provided to direct these efforts.

Acknowledgments

I present my gratitude to my supervisor Ross Cullen. Without his direction, support and patients this dissertation would not have been possible. I learned a great deal through this process, much of which is attributable to Ross's efforts.

I present my love to my family. Without their direction, support and patients very little would have been possible. A day does not pass without a demonstration of how lucky I am to have them.

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Abbreviations and Acronyms

CAC	Command-and-Control
ECan	Environment Canterbury
ETS	Emissions Trading Scheme
MBI	Market-based Instruments
MC _p	Marginal Private Costs
MC _s	Marginal Social Costs
MEC	Marginal External Cost
MNPB	Marginal Net Private Benefit
NTP	Nutrient Trading Programme
RMA	Resource Management Act 1991
RPS	Regional Policy Statements

Chapter 1 Introduction

1.1 Problem Framing

Water quality is rapidly becoming one of the most pressing environmental issues facing many parts of the world today. While, by international standards, the quality of New Zealand's freshwater is high (OECD, 2006), it is none the less declining (Ministry for the Environment, 2007). A 2002 overview of the water quality of the rivers and streams in Canterbury found that all but mountain rivers exceeded guideline values for nutrient enrichment (Meredith & Hayward, 2002:22).

Water is essential to New Zealand's social, cultural, and economic well-being. Environment Canterbury's Proposed Natural Resources Regional Plan recognizes water resources as important for aquatic ecosystems, aesthetic, cultural and recreation values, tourism, and as a source of water for drinking, industry and agriculture. This value of water quality is further substantiated in a growing public unease. Water quality related issues consistently rank high among issues of environmental concern in Canterbury (Cook, 2008), and as the single most important environmental issue for New Zealand (Hughey, Kerr & Cullen, 2008:75).

Water pollutants originate from a variety of sources, including agricultural land uses, community sewerage schemes, industrial discharges to land, septic tanks and urban runoff. According to the Ministry for the Environment (2007:304) water quality is generally poorest in rivers and streams in urban and farmed catchments. This reflects the impact of non-point-sources of pollution in these catchments, such as urban stormwater, animal effluent, or fertiliser run-off. While discharges from point-sources remain a significant influence on water quality, because these sources are now largely controlled under the Resource Management Act 1991, the attention of many resource managers has turned to non-point-source pollution.

Traditionally, approaches to the management of diffuse source pollutants in New Zealand have been dominated by principles of command-and-control (CAC). Such approaches rely on regulation, monitoring and the threat of enforcement through penalties to derive a desired behaviour from polluters. While, as highlighted above, such approaches have proven to be successful in addressing point sources of water pollution, their effectiveness in addressing diffuse source of water pollution has often been limited (Selman, Greenhalgh, Branosky,

Jones, & Guiling, 2009). Market based instruments (MBIs) offer policy makers some innovative tools for water quality management that have the potential to overcome some of the problems facing traditional CAC approaches. Targeting environmental outcomes rather than the source of pollution, MBIs' incorporation of market opportunities and processes offer stakeholders the ability to develop and implement their own innovative and economically efficient solutions. This not only limits the effects of imperfect information existing between the polluter and the regulator, but offers a way to introduce more flexibility and cost effective ways of achieving water quality goals (Hatton, Connor & Morrison, 2004:13).

Nutrient Trading Programmes (NTPs) are one type of MBI that are gaining international popularity as an effective mechanism to meet water quality goals (Selman *et al.*, 2009:2). With a foundation dating back to as early as 1960, there exists a substantial field of theoretical understanding of the strengths and weaknesses associated with this approach. Its popularity has also allowed for a great deal of practical understandings to be developed regarding its design and implementation. Perhaps most importantly, this experience has also demonstrated that NTPs are not an appropriate approach in all circumstances.

1.2 Aim and Objectives

Aim

The aim of this research is to contribute to the more effective management of the world's most essential resource, water. To do this, this dissertation evaluates the potential for a NTP as an effective water quality management tool in the Selwyn District of New Zealand. It is not the intention of this research to provide a definitive answer regarding the adoption of an NTP, but rather to develop a preliminary understanding of its viability from which future work regarding its desirability can be directed.

Objectives

This research has three objectives:

1. Develop an understanding of the potential benefits of a Nutrient Trading Programme to water quality management efforts in Selwyn District.
2. Establish a set of criteria by which the success of an NTP can be determined.
3. Use these criteria to assess the viability of an NTP in Selwyn District.
4. Based on these findings, recommend future policy options in relation to the use of an NTP in the Selwyn District.

1.3 Structure of Dissertation

This dissertation consists of six chapters. Chapter two, *Method*, outlines the research method used to inform this dissertation. It will also discuss the key limitations associated with this research and how they were taken into account in the research process.

Chapter three, *Theoretical Foundations of Nutrient Trading*, provides a theoretical overview of NTPs. This section starts with an introduction and analysis of MBIs as a whole, broadly highlighting their theoretical underpinnings, key assumptions, strengths and weaknesses. It then moves into a more direct exploration of nutrient trading as a water management tool. It highlights the reasoning behind its' use, as well as compares it to other management approaches.

Chapter four, *Framework of Assessment*, draws on a review of MBI assessment literature to introduce the key conditions affecting NTP success in implementation. In doing so it establishes the criteria by which the viability of an NTP in Selwyn District will be assessed in chapter five, *Evaluation of Selwyn District*.

Finally, chapter six, *Conclusion*, draws on this previous analysis to determine the viability of an NTP as a water quality management tool in Selwyn District. From this conclusion, recommendations are derived as well as some insights regarding potentially useful future research directions on the subject.

Chapter 2 Method

2.1 Introduction

This chapter describes the method used in this dissertation. It doing so, it also presents the key limitations and discusses how the effects of these were minimized. It concludes by outlining the contribution this dissertation is intended to provide current understandings in the field.

2.2 Method

The method used to inform this dissertation was a critical literature review. While all information was collected through this method, given the nature of the information needed, as well as its availability, the specific form this literature review took varied. Figure 2.1 provides a graphical representation of the process through which this dissertation is informed. This research was broken down into four stages, each directed to meet one of the four objectives.

2.2.1 Stage 1

Stage 1 of this research develops an understanding of the potential benefits of a NTP to water quality management efforts in Selwyn District. This was conducted through a critical review of the literature pertaining specifically to the theoretical development of NTPs in water quality management. The literature reviewed was gained through a suite of journal and catalogue search engines. Google Scholar was also used to find works referenced by literature found through library resources but not available through the library search engines.

A major limitation associated with this method is its reliance on the validity of the work consulted. In order to maintain the highest possible quality of information used, this literature review was restricted to peer reviewed work, and established textbooks in environmental economics. This ensures that the information used to develop understandings in this dissertation have been previously evaluated with a degree of academic rigor. Furthermore, in order to verify the accurate interpretation of critical works, where possible, commonly cited ideas were traced back to the original source.

STAGE	OBJECTIVE	OUTPUT	METHOD
STAGE 1	Develop an understanding of the potential benefits of a Nutrient Trading Programme to water quality management efforts in Selwyn District.	Theoretical Foundations of NTPs	Desktop review of economic literature
STAGE 2	Establish a set of criteria by which the likely success of NTP implementation can be determined.	Framework of Assessment	Desktop review of MBI assesment literarure
STAGE 3	Use criteria developed in STAGE 2 to assess the viability of an NTP in Selwyn District.	Evaluation of Selwyn Catchment	Desktop literature review of relevant fields
STAGE 4	Discuss significance of findings in STAGE 3 and recommend future policy options in relation to the use of an NTP in Selwyn District.	Conclusions & Recommendations	

Figure 2.1 Graphical Representation of Research Approach

2.2.2 Stage 2

Stage two of this research establishes the set of criteria by which the likely success of NTP implementation can be determined. Similar to stage one, this was conducted through a critical literature review, however unlike stage one which was based on theoretically focused literature, stage two reviewed literature pertaining to the practical implementation of MBIs. As a result of the more experimental nature of these understandings, while this stage does draw on peer-reviewed works, unlike stage one, it also draws on a range of grey literatures.

Again, a major limitation of this method is its dependence on the accuracy of literature consulted. While stage one was able to manage this limitation through the reliance on peer reviewed works, the incorporation of grey literature in this stage decreases certainty of the accuracy of the findings presented within the literature consulted. However, while not academically peer reviewed, the grey literature used in this stage was drawn from sources that underwent an institutionally peer-reviewed process such as those that exist at CSIRO, Motu, the Treasury, the Ministry for the Environment, AgResearch, and the World Resource Institute.

Method

A second limitation in stage two's method is the time lag that exists between understandings developed and its appearance in literature. This time lag can result in a discrepancy between understandings found in the field and understandings found in the literature. Fortunately, as a result of the current popularity around the world of NTPs in water quality management, as well as their current application in New Zealand, the impacts of this limitation were mitigated by the abundance of relevant and recent work in the field.

2.2.3 Stage 3

Stage three of this research evaluates the current state of Selwyn District with regard to the assessment criteria developed in stage two. Similar to previous stages, this was conducted through a critical literature review, however, unlike previous stages, this review included a wider scope of literature. This included not just literature pertaining to NTPs, but those pertaining to the critical factors developed in stage two including literature in biophysical sciences, economic, and political sciences. While covering a wider range of disciplines, the literature reviewed was once again limited to a mix of academically peer review and institutionally reviewed grey work.

The major limitation in this stage of research is the range of technical fields it covers. While the use of secondary work presented a limitation in previous stages, in this stage the use of secondary work is a benefit as it allows for understandings to be drawn from experts in the relevant fields rather than trying to build these understandings through primary data. That being said, it still requires the successful navigation of the literature in these fields as well as the proper interpretation of their findings.

2.3 Summary

The aim of this research is not to provide a definitive answer regarding the adoption of an NTP, but rather to develop a preliminary understanding of the critical factors likely to affect its viability, and to provide some initial analysis from which the appropriate direction of further in-depth research can be derived. In this context, the measures taken to address the above-mentioned limitations are therefore deemed appropriate and effective.

Chapter 3 Theoretical Foundations of Nutrient Trading

3.1 Introduction

Increasingly markets are being proposed as mechanisms to help address issues in natural resource management. The unique benefits MBIs offer policy makers have led, not only, to their increased use world wide, but also to their application to a growing number of resource management issues. NTPs are one type of MBI gaining considerable popularity in water quality management. In order to better understand the potential role that NTPs can play in water quality management in Selwyn District, this chapter will explore the economic principles on which they are founded, and discuss NTP's key benefits and limitations in reference to alternative policies in water quality management.

3.2 Market Failure

An allocatively efficient distribution of resources is one in which society's welfare as a whole is maximized. The "first theorem of welfare economics" proposes that, provided the existence of certain conditions, allocative efficiency can be realized through private markets on their own, with no interference from government (Fullerton & Stavins, 1998:433). In other words, given the initial income distribution, it is believed that the individual's expression of preferences through the market, both in supply and demand, will result in a distribution of resources that will maximize not only their personal welfare, but that of society as a whole. This expression of the rational individual's expression of self interest is what Adam Smith (1759) first referred to as '*the invisible hand*'. Figure 3.1 is a basic graphical representation of such an invisible hand at work, illustrating the net social surplus, highlighted in green, that is believed to result from such a voluntary market exchange.

Theoretical Foundations of Nutrient Trading

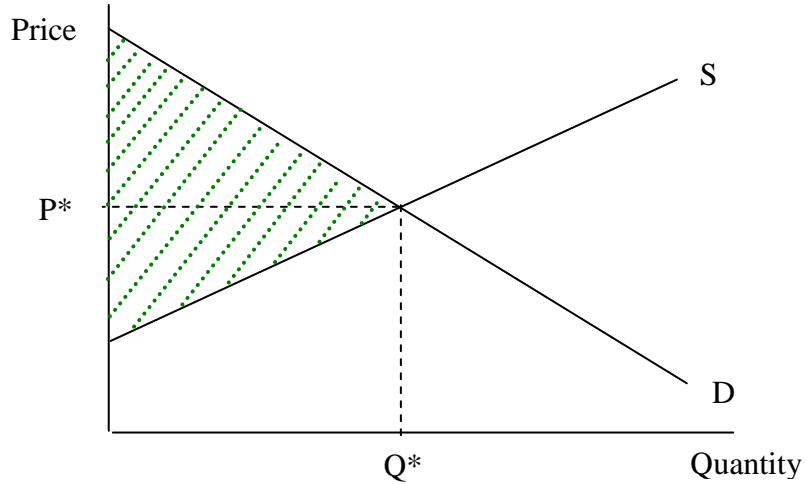


Figure 3.1 *Neo-classical Net Social Surplus*

When applied to the provision of environmental goods and services, the invisible hand often fails to arrive at such efficient outcomes. This failure is ultimately a product of misrepresentation of the true value of goods and services within the market. As a result, the privately optimal decision deviates from that of socially optimal, as the true value of decisions are not reflected in the market exchange, leading to non-optimal allocation of resources (Asafu-Adjaye, 2000:64). Figure 3.2 provides a graphical representation of a market allocation with and without considering pollution and its effects on net social surplus.

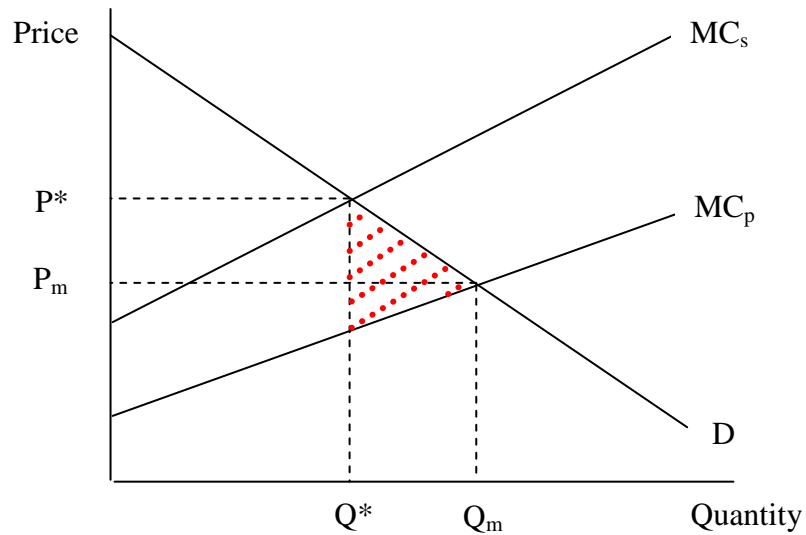


Figure 3.2 *Market Allocation with Pollution*

Theoretical Foundations of Nutrient Trading

Using dairy farming as an example, this graph shows the demand for milk in the demand curve D, the dairy farmers' marginal cost of production, marginal private costs (MC_p), and society's marginal costs of this dairy production, marginal social cost (MC_s). Because the dairy farmer does not bear all the cost of the pollution their production process creates, they have no financial incentive to internalize those cost into their decision making. As a result they will choose to produce a quantity of goods where their profits are maximized, Q_m . However that choice is not socially efficient. Because society bears the cost of the pollution created in the production process, for example, through reduced water quality society's optimal production output would be Q^* . The red highlighted triangle area is the dead weight loss to society at a production level of Q_m (Turner, Pearce & Bateman, 1994:23-24).

This failure to appropriately internalise the true costs or benefits of an exchange is known as an *externality*. Within the economic literature there is a pervasive belief that the cause of many externalities, particularly with respect to pollution, can be traced to the open access of natural resources (Turner *et al.*, 1994:26). Open access resources lack property rights which are essential to provide incentives for individuals to restrict their use of them. In the case of water pollution, this resource is the ecosystem's assimilative capacity. As long as polluters stand to gain from exploiting this resource, it will be at risk of being overused.

There are three principle means by which governments can intervene in an attempt to remedy a market failure. These are outlined in Table 3.1.

Table 3.1 Options for intervention to address market failures

<i>Means</i>	<i>Description</i>
Facilitative	Measures designed to improve the flow of information and corresponding signals and incentives without providing any direct incentive payments.
Incentive	Measures designed to directly alter the structure of pay-offs to agents and are usually specifically intended to substitute price signals that are generated within markets for other goods and services.
Coercive	Non-voluntary measures designed to compel management change using the coercive powers of government.

Source: Hatton *et al.* (2005)

3.3 Command-and-Control

Traditionally, governments have used regulatory instruments to address these market failures (OECD, 1989:23). Known as a Command-and-Control (CAC) approach, these regulations use the threat of sanctions to coerce polluters into the adoption of specific technologies or management practices that are thought to lead to a desired outcome (Nguyen, Woodward, Matlock, Denzer & Selman, 2006:2-3). CAC have two components: first, a regulation which places a restriction on certain behaviour; and second a set of penalties which are allocated for non compliance. In the instance of addressing point sources of pollution, for example, industrial air emissions, the CAC approach has proven to be very effective (Nguyen *et al.*, 2006:6).

There are several reasons for the prevalence of the CAC approach to dealing with water pollution. For one, the CAC approach allows governments to set specific targets. Although the competition by rent seekers within any market might be able to skew the specific target set by government, theoretically, this ability of governments to establish a desired outcome gives them the opportunity to take into consideration a wide range of economic, social and cultural variables, and establish a target with a relatively high social net benefit (Turner *et al.*, 1994:190).

Secondly, regulations are a relatively straight forward process for governments to achieve desired outcomes (OECD, 1989:24). CAC approaches establish measurable requirements, such as the adoption of specific technologies or best management practices, and therefore offer a clear process through which desired outcomes can be sought. They also establish a clear process through which these requirements are monitored and enforced and can cater penalties to ensure the desired level of compliance.

Despite these potential benefits, CAC approaches do have several key limitations as pollution control policy instruments. To start, as Stavins (1998) points out, CAC approaches can have a negative impact on the development of environmentally beneficial technologies and production methods. Because they use the threat of punishment rather than the encouragement of reward, they offer little incentive for polluters to seek

pollution reduction opportunities beyond the targets specified in the regulation. Furthermore, CAC approaches often prescribe the specific technologies that must be adopted. As a result they not only limit the adoption of existing technologies, but more importantly, they stifle the innovation of new, more effective, technologies (Stavins, 1998:2).

Also, as a review of CAC approaches to pollution control conducted by Nguyen *et al.* (2006:6) found, CAC approaches are not cost effective. The main reason for this is that, by and large, CAC approaches place the same emissions requirements on all sources of pollution relevant to the target they are trying to meet. While the equal division of this target amongst the various sources of pollutions might seem to be an equitable approach, by regulating requirements at the individual or firm level instead of at the aggregate level, the CAC approach fails to take advantage of the emissions cost heterogeneity existing between the various sources of pollution. As a result the CAC approach costs the economy as a whole more by not encouraging most emission reductions to flow from the least cost sources (Nguyen *et al.*, 2006:3).

Finally, CAC approaches are often politically unpopular because of the costs they impose on polluters and because of the lack of flexibility that they afford polluters. As a result of this, CAC approaches often require a high level of political will to not only be enforced, but implemented in the first place (Turner *et al.*, 1994:192). Ultimately this leads to a reduced likelihood of achieving a desired outcome, in this case, improved level of water quality.

As Tietenberg (1986) summarizes, these limitations are ultimately the result of the failure of the CAC approach to match capabilities with responsibilities. As a result, regulatory authorities responsible for setting a target and delineating a means of achieving it, have too little information available to them to do this cost effectively. However, those that do have this information, the polluters, lack the incentive necessary to voluntarily accept their cost effective responsibility or disclose unbiased cost information to regulators so that it can make a cost-effective assignment.

3.4 Market Based Instruments

MBIs are policy tools that use the market as a means to encourage the behaviour necessary to meet a desired environmental outcome (Stavins, 1998:1). By harnessing the power of the market, MBIs employ aspects of both facilitative and incentive based measures, rather than the explicit coercion employed by CAC approaches. By changing incentive structures associated with a particular behaviour, MBIs seek to align private and social benefits so that the best private choice can be made to coincide with the best social choice (Tietenberg, 1990:17). Figure 3.3 outlines the two principal ways in which MBIs do this with respect to pollution control.

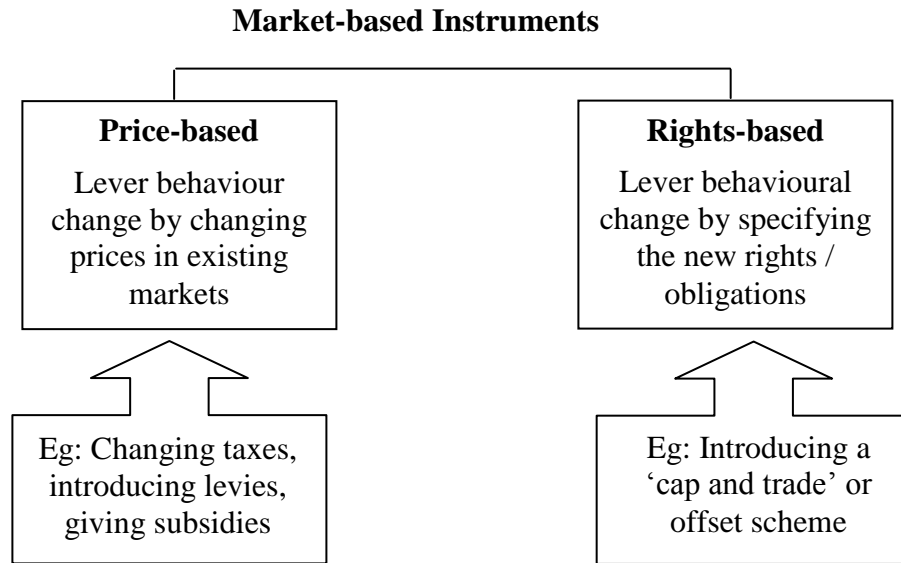


Figure 3.3 Types of Market-based Instruments

Source: Whitten, Van Bueren, & Collins (2004)

3.4.1 Price-based approach

The price-based approach goes back to the early 1920s when Pigou first conceived of the potential use of taxes and subsidies to recalibrate differences found between private and public costs (Paragahawewa, 2006:1). Supported more recently by Haas (1970), and Baumol and Oates (1972), the price-based approach argues that governments should impose taxes to reach the price which yields the desired levels of pollution. This would be done by setting a tax equal to marginal externality at the optimum, which would have

the effect of creating a post-tax profit that is maximized at the optimal level of pollution. Figure 3.4 provides a graphical representation of this tax.

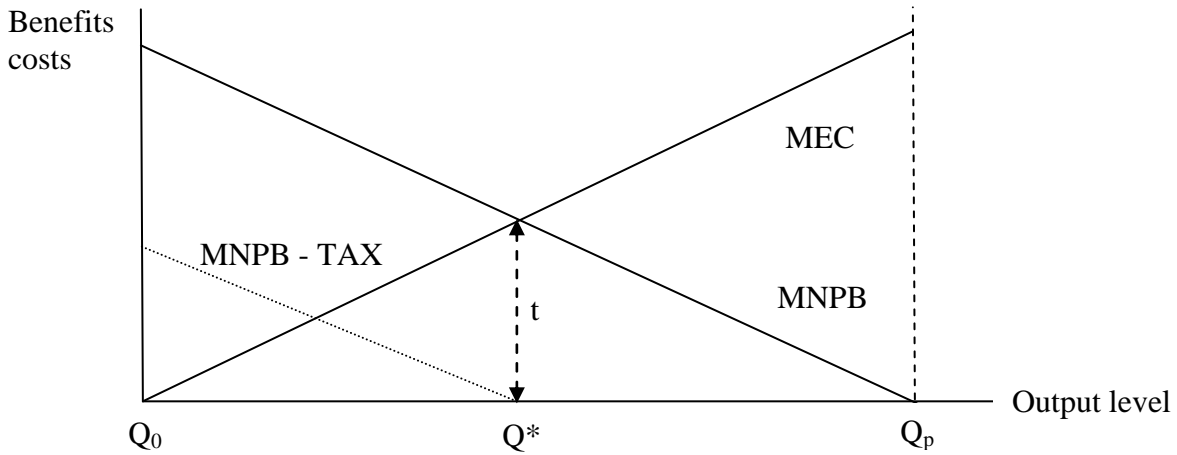


Figure 3.4 Pigovian Tax

The MNPB curve represents the marginal net private benefit function of the polluter. MEC curve represents the marginal external costs function, in other words the marginal damage suffered by society. Without government intervention, the polluter would produce until Q_p , where their MNPB equalled zero. The tax effectively increases the costs of production, reducing the MNPB curve to MNPB-TAX. At efficiency, this tax is set to a level where it adjusts MNPB to equal zero at the social optimal level of production, Q^* , as is represented in the graph.

The revenue this approach generates is one significant benefit of this approach for the regulators. Unlike the CAC approach that only collects revenue through fines for non compliance, this form of a price-based approach is continually collecting revenue from polluters as long as their emissions are above zero. While regulators might appreciate this increased revenue, there are some critical limitations in the price-based approaches' ability to distribute these gains to society as a whole.

In order for this approach to reach allocative efficiency, Q^* , it would require individual tax rates to be applied at the firm level. In this respect it is similar to the limitations of CAC approaches. This cost of firm level administration would erode the gains the tax

achieved by driving up transactions costs (Tietenberg, 1973:202). As highlighted previously, regulators are not in a position to know the external cost functions of firms and are therefore unlikely to identify the optimum tax rate of Q^* . If they were, it would only be through a series of successive approximations whose recalibration with every change in market variables would, once again, erode any gains in efficiency that may have been achieved (Carter, 2001:298-299).

3.4.2 Rights-based approach

Coase (1960) introduced the rights-based approach by suggesting that creation of markets in the externalities themselves as a means of addressing their effects on net social surplus (Turner *et al.*, 1994:152). Mishan (1967) and Dales (1968) built on Coase's hypothesis by proposing that a price based system be used to allocate such externality rights through an artificial market. In such a market, the right to pollute would be traded between the sufferer and the polluter. Through this exchange, in accordance with the '*first theorem of welfare economics*' outlined above, the market would reach an allocatively efficient distribution, in this case, resulting in the socially optimal level of pollution. Table 3.2 outlines the four main characteristics of efficient property rights structures that would be needed for such a market to function.

Table 3.2 Property rights characteristics

<i>Characteristic</i>	<i>Description</i>
Universality	All resources are privately owned and all entitlements are completely specified.
Exclusivity	All benefits and costs accrued using the resources accrue to the owner, either directly or indirectly by sale to others.
Transferability	All property rights are transferable from one owner to another in a voluntary exchange.
Enforceability	Property rights are secure from involuntary seizure or encroachment by others.

Source: Tietenberg (1986)

Figure 3.5 provides a graphical illustration of such a transaction.

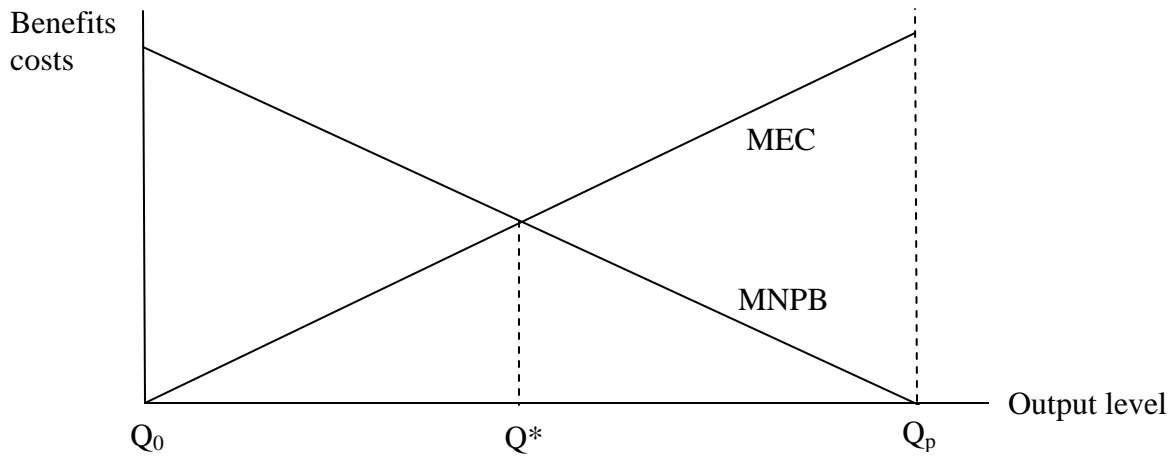


Figure 3.5 Coase curve

The MNPB curve, as noted previously, represents the marginal net private benefit function of the polluter and the MEC curve representing the marginal external costs function, in other words the marginal damage suffered by society. The efficient solution is given at the intersection of MNPB and MEC. Coase predicted that under a rights based system, this point of equilibrium would emerge because at a quantity of pollution greater than Q^* , the sufferer would be willing to pay more to stop pollution than the polluter would be gaining from their production of the pollution. *Vice versa*, at any point lower than Q^* , the cost of the pollution to society would not be significant enough for it to be willing to offset the benefits gained by the polluter through production. If correct this approach implies a minimal need for government intervention in environmental problems.

In reality such a market in externalities faces a key problem of complexity. As a result of the pervasiveness of externalities throughout all economic activity, there would be too much information for such a mechanism to process efficiently. Either the costs of collecting the information would limit any gains it may achieve or due to a lack of all required information the market will be plagued with imperfectly informed transactions. The result of either of these two effects makes an economy wide application of such an approach infeasible (Atkinson & Tietenberg, 1991:18).

The limitations in these two MBI approaches highlight a growing sentiment among economists that the amount of information required for a free market to establish the optimal level of pollution, likely exceeds what can realistically be collected and used. However, while this evidence suggests that the setting of desired levels of pollution should be a matter of collective decision making through the political process, rather than left to the market itself, once the decision is made about desired pollution levels, economics has a great deal to say about how this pollution level is allocated among competing users (Tietenberg, 1973:193-194).

3.5 Nutrient Trading Programmes

NTPs are one form of rights-based MBI that are gaining popularity as an effective means of achieving water quality targets. While there can be much variance in the specific design of NTPs, all share three common attributes. First, all require that a 'cap', or target, be first placed on pollution levels of a specific body of water. Second, permits, the aggregate of which equal the specified target, must be allocated amongst the relevant actors that are contributing to the pollution levels of that body of water. Finally, a mechanism for exchange must be developed through which actors can trade those rights to pollute, creating a market for their exchange (Paragahawewa, 2007:1).

Emissions Trading Schemes (ETSs), from which NTPs are derived, were first used to address SO₂ and NO₂ emission, as part of the Environmental Protection Agency efforts to address acid rain in the United States (Nguyen *et al.*, 2006:5; Atkinson & Tietenberg, 1990:17). This policy followed its successful predecessor which required new sources of pollution to acquire offset emission permits from existing emitters. Until this offset scheme, which was designed to reduce conflict between air-quality improvements and economic growth, the emission trading scheme was designed to increase the costs effectiveness of the regulatory policy controlling existing sources of air pollution (Atkinson & Tietenberg, 1990:17-18).

While NTPs can be applied to a range of water pollutants including temperature, selenium, and sediment, it is most commonly applied to nutrients such as nitrogen and

phosphorus (Selman *et al.*, 2009:2). NTPs can also be designed to address the specific sources of pollution within a given catchment depending on the nature of the water quality problem.

Currently, there are 57 examples of NTPs worldwide, spread throughout Canada, the United States, Australia as well as two here in New Zealand (Selman *et al.*, 2009:1). Table 3.3 provides a breakdown of the basic requirements of all NTP programs.

Table 3.3 Critical elements of a NTP approach to water quality management

<i>Element</i>	<i>Description</i>
Public water quality goals	Set by national, district or local authorities based on public input and can be defined in terms of ecological, recreational or safety standards.
Pollution cap for a watershed	Limit on the total pollutant load from all sources to a water body. The justification for and size of the cap is based on the public water quality goals.
Regulated baseline	Numeric level of pollutant load allowed for at a particular point in time.
Unregulated baseline for agricultural non point sources	Minimum level of pollution abatement that an unregulated agricultural operation must achieve before it can participate in a trading program. Sometimes called a threshold.
Credits	Units of goods (pollution reduction) to be traded in the water quality credit market. Credits are generated for every unit of pollution reduction beyond the baseline level.
Sellers (credit suppliers)	Dischargers that reduce pollution below the baseline and generate credits for sale in the market. Credits can also be sold by intermediaries, as allowed by program rules.
Buyers (demanders for credits)	Dischargers with regulated baselines for whom pollution reduction is expensive. For these sources, it is less costly to buy pollution credits from other parties and use these credits to help achieve their baseline loads. Credits can also be purchased by intermediaries and third parties, as allowed by program rules.
Trading ration	Number of load reduction credits from one source that can be used to compensate excessive loads from another source.
Regulator	Entity that determines the water quality goals, establishes caps for pollutants in watershed, approves and administers the trading program and monitors and enforces the rules.

Source: Abdalla, Borisova, Parker & Blunk, (2009)

A well-designed and operating NTP program can offer policy makers a number of economic, ecological, and even political benefits. To start, NTPs have been demonstrated to be very resource cost effective instruments in pollution control. A

resource cost effective policy is one which is able to equalize the marginal cost amongst firms to meet an aggregate target (Stavins, 1998:1). In other words, it is able to achieve the desired pollution target with the last unit of pollution reduction being equal across all emitters (Nguyen *et al.*, 2006:3-2). As demonstrated previously by the Coase analysis, allowing the free trade of pollution rights takes advantage of the abatement cost heterogeneity found amongst firms, allowing pollution targets to be met at the lowest aggregate resource cost to the economy. In watersheds, where the cost of non-point source pollution abatement can be up to 65 times cheaper than that of point sources, these costs savings can be significant (Bacon, 1992, as cited by Nguyen *et al.*, 2006:4).

The overall costs effectiveness of NTPs is further enhanced by the comparatively low transaction costs associated with their implementation. Unlike the rights-based approach discussed previously, because NTPs are targeted to a specific externality, in this case nutrient pollution, the information requirements, and therefore the transaction costs associated with information gathering, are much more limited. Secondly, by allowing firms the flexibility to seek their own methods of achieving targets, NTPs creates a means of revealing firm level pollution abatement costs information that other approaches could only achieve through cost intensive firm level research (Hatton *et al.*, 2004:17). Finally, growing innovation in the way that markets are set up have been proven to greatly reduce the transaction costs associated with market friction by increasing the ease with which buyers and sellers conduct transactions. NutrientNet, set up by the World Resource Institute to function as a clearing house for pollution rights trading in the United States is but one example (Selman *et al.*, 2009:14). While the issue of pollution monitoring remains an important administrative cost of NTPs, because it is a common costs to all pollution reduction approaches, it should not be considered a critical cost.

As Kerr, Lauder and Fairman (2007) point out, there are also several potential political benefits associated with the NTP approach. As NTPs are less prescriptive than CAC approaches they afford polluters considerable flexibility in the way that they achieve their target. NTPs have proven to be more politically acceptable than the prescriptive measures

of CAC approaches by allowing decision around such things as land use, technologies used, and management practices to remain in the control of the land owner. In addition, the flexibility of how the costs of achieving a target are spread within NTPs allows the regulating body the opportunity to structure allocations in a way that compensates vulnerable groups, helping them adjust and thereby reducing opposition to the policy (Kerr *et al.*, 2007:4). There will also be diverse representation of the community, including Maori, amongst the owners of pollution permits, and because of the direct participation that permit holders have in the way that targets are met, NTPs offers a higher level of community engagement in the pollution control process, thereby increasing its legitimacy (Kerr *et al.*, 2007:5).

NTPs can also offer considerable ecological benefits over other pollution control approaches. To start, because of the potential revenue to be gained through the sale of discharge permits, there is a positive economic incentive to adopt and innovate abatement technologies and best practices. Furthermore, because there is no individual limit as to how much one can gain from pollution reductions, there is no invisible floor to this innovation. Finally, because NTSs do not prescribe firm level outputs, they do not impose burdensome investments on those polluters with particularly high abatement costs. By allowing for the purchase of credits in the market, NTSs offers these firms less capital intensive means of meeting their requirements, and therefore reduce the likelihood of their non-compliance (Kerr *et al.*, 2007:5). All of these features have the potential to contribute to improved ecological outcomes.

Despite the benefits of NTPs, they are none the less subject to their own set of limitations. For one, NTPs are limited in their ability to deal with the spatial effects of pollution. By setting one pollution target and allowing for the trade of pollution rights between all polluters contributing that specified pollution load in a defined geophysical area, it does not take into account the localized effects of concentrated pollution. These 'hot spots' may not affect the aggregate target, however, they can have considerable localized effects. For example, if in the Selwyn catchment a pollution target was set for Lake Ellesmere, it would not restrict where the contributing pollutants originate from. As

a result, through the course of pollution permit trading, it is possible that quantities of the allocated rights become so concentrated in one area up stream as to have localised negative ecological, social and economic effects without breaching the aggregate target. While there is growing research on how such special considerations can be integrated in to NTP policy, it none the less remains a considerable shortfall of the NTP approach.

Secondly, unlike the claims of other MBI approaches, NTPs are not likely to achieve an economically efficient level of pollution. That is to say, there will likely be room to yield greater net social benefits than those derived from an NTS (Nguyen *et al.*, 2006:3). Unlike the price-based approaches discussed previously, while NTPs use the market to distribute pollution rights, they do not use the market to determine the number of rights that exist. Instead, this target is set through a political process, that for the same reasons outlined in the CAC limitations, is unlikely to be set at Q^* , the social optimal level of pollution. Under this approach, the exchange does not occur between a polluter and a sufferer, but because of the publically imposed cap, trade only occurs amongst the various polluters themselves.

Finally, the most significant limitation to the NTPs approach, and all MBIs in general, is the deviation that exists between their theoretical roots and their practical applications. It is often the case that the assumptions made within the theoretical construction and justification to these policies are not realized in their application. In practice, NTPs encounter implementation realities that can either be ignored or glossed over in the theoretical discourse. As a result, any application of an NTP requires considerable insight into the local context.

3.6 Summary

Nutrient Trading Programmes are an emerging innovation in the way water quality is managed. By harnessing the power of the market they are able to achieve several economic, political and even ecological benefits. Furthermore, their growing application around the world offers policy makers considerable insights into their effective design and application. Despite these benefits, NTPs are not a viable policy instrument in all

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circumstances. There are a number of factors which have considerable impact on their ability to achieve the benefits discussed above. The next chapter will survey the most critical of these factors and establish a framework by which to evaluate the viability of NPS in Selwyn District in Chapter 5. Chapter 6 will discuss the findings and offer ways forward.

Chapter 4 Framework of Assessment

4.1 Introduction

This chapter brings together the findings from a number of Water Quality Trading evaluation studies and establishes four key categories of conditions critical to NTP success. Understanding these conditions and their effects on NTPs is essential to effectively evaluating the viability of an NTP as a water quality management policy in Selwyn District. In principle, as outlined in the previous chapter, establishing a NTP is a three step process involving setting an overall cap on pollution, allocating portions of that cap as emission permits, and allowing the trading of those permits amongst polluters (King, 2005:72). However, as with all markets, the efficiency and effectiveness of markets in environmental assimilative capacities are dependent on a certain set of conditions. This has been evident since the earliest application of an NTP on the Fox River in Wisconsin failed to give rise to a single emissions credit trade in its 14 years in operation (Woodward, Kaiser & Wicks, 2002:977).

4.2 Institutional and legal

The success of any policy is critically dependent on its ability to operate within the existing institutional and legal framework. This need is compounded with regard to NTPs as the institutional framework is critical to creating the appropriate incentive for polluters to use the market mechanism as a least cost means to manage pollution (Selman *et al.*, 2009:2). There are three institutional conditions that have been shown to be important in ensuring this incentive.

First, as Guerin (2004) points out, a key consideration in designing any use rights system is the extent to which it is accommodated under the existing legal frameworks. The incentive associated with NTP trading is critically dependent on the legal systems' ability to adequately define property rights to discharge pollution, which outlines the rights, privileges, and limitations associated with their ownership. The legal structure is also critical to the policy's ability to effectively set a water quality target, which creates the scarcity needed to give these property rights the value necessary for a market to form.

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Woodward *et al.* (2002) point out that this consideration is particularly important with regards to NTPs as the goods which are being exchanged in the market, i.e. the right to emit pollution have little meaning, or value, outside of this legal context. Thus without a clear and robust legal framework, the value of, and intern demand for, pollution credits will likely be limited.

The division of organisational jurisdiction is a second important institutional factor affecting the viability of NTPs. Organisational jurisdiction determines not only who has the authority to implement an NTP, but more importantly who is responsible for the various facets of its operation, such as monitoring and enforcement. As King (2005) points out, the increased complexity associated with such division of responsibilities between various organisations at several levels of government can have considerable impact on the success of NTPs. This complexity can not only reduce the communication needed for effective coordination, it can lead to a blurring of the lines of responsibility. As a result, critical components of the policy may fail to be owned by any one level of jurisdiction and therefore fail to be adequately implemented.

A final important institutional condition is the capacity of the relevant organisations to effectively monitor and enforce the program. As King (2005) highlights, the importance of this capacity is a product of the fact that there is no “natural” demand in regulation-driven markets such as an NTP, rather demand is dependent on the monitoring and enforcement of the market defining regulations. This capacity is not only dependent on resources, particularly funding, but as Sharp (2002) points out, is also dependent on the scientific and technical expertise of the regulating authorities. Without the appropriate capacity the policy will struggle to be appropriately monitored and enforced, reducing its viability as a functioning market. As Guerin (2004) highlights, it is easy to underestimate the resourcing requirements to support such a legally enforceable system. It is important, therefore, that such institutional limits are recognised and properly accounted for in the evaluation of an NTP’s viability.

4.3 Economic

Along with institutional conditions, economic conditions also play an important role in determining the level of demand for emission permits (Selman *et al.*, 2009:2; King, 2005:71). In this case rather than the negative incentive of regulatory enforcement, economic conditions determine the level of positive incentive in the form of potential financial gains. There are three key factors affecting the potential for economic gains in NTPs.

First, heterogeneity in abatement cost must exist amongst polluters in order for the exchange of emissions credits to develop. Abatement costs are affected by variations in production inputs, such as available pasture land area and stocking as well as a variation in the potential management strategies, such as stand-off pads and riparian margins (Kampas & White, 2003:220). This heterogeneity is critical to NTP success as it creates the opportunity needed for there to be economic gains from the trade of emissions credits between polluters (Abdalla *et al.*, 2007:220). If there is not sufficient abatement costs heterogeneity within a catchment, there is unlikely to be any trading of emissions permits, as the cost for a polluter to buy a permit to offset their emissions, would equal the cost for them to reduce their own emissions. As not all watersheds will have polluters with sufficient cost heterogeneity, it is important that the composition of polluters be carefully considered prior to the implementation of a NTP.

A second important economic characteristic is the size of the emissions credit market. In this case, the size of the market refers to the number of polluters included in the program. While costs heterogeneity is needed to motivate the exchange of emissions permits, market size is needed to allow this exchange to occur. In thin markets, where there are a small number of polluters, there will be few opportunities for those motivated to sell permits to find those motivated to buy them (Turner *et al.*, 1994:23). This reduced opportunity not only decreases the competitiveness of the market thereby decreasing the efficiency gains of trade, it can actually prevent trades from occurring in the first place. As with abatement costs heterogeneity, not all watersheds will exhibit a thick enough

market to successfully support an NTP approach, therefore a survey of likely market participants needs to be conducted as part of a viability assessment.

Transaction costs are a final economic consideration. Transaction costs are the costs associated with participating in the market, including everything from finding someone to trade with to undertaking verification of the terms of trade (Turner *et al.*, 1994:153). As Turner *et al.* (1994:153) highlight, despite often being left out of theoretical analysis, transaction costs play an important role in determining the level of economic gains a market can achieve. While there might exist adequate abatement costs heterogeneity for gains to be made through trade, those gains have the potential to be offset by high transaction costs, reducing the incentive to participate in the market (Selman *et al.*, 2009:2). While all markets will incur some level of transaction costs, they can be limited through the way the market is structured (Woodward & Kaiser, 2002:374). It is important for NTP success that there be local mechanisms that allow for the market to be structured in such a way as to keep such costs to a minimum.

4.4 Biophysical

The success of any water quality policy is dependent on its ability to accurately account for the interaction of relevant biophysical and ecological dynamics. A failure to do so jeopardizes the policy objective, regardless of its successful implementation. In the case of NTPs, there are two particular biophysical dynamics whose uncertainty can jeopardize the viability of the instrument.

First, because NTPs use proxies rather than direct measurements to determine non-point source levels of pollution, their success is particularly dependent on effectively capturing biophysical cause and effect relationships associated with nutrient loss (Selman *et al.*, 2009:13). Without a sound understanding of this relationship, emission reduction mechanisms have the potential to be over valued and fail to keep emissions within the allocated cap. Furthermore, because this system involves trading a valuable right, uncertainty over the effects of any mitigating activity casts uncertainty over the monetary value. Because the system involves both trading a potentially valuable right, as well as

the distribution of potentially ecologically harmful concentrations, it is important that estimation methodologies used to calculate emissions are robust, consistent, and standardized in order to be defensible from a scientific and regulatory perspective (Selman *et al.*, 2009:13).

Second, as NTPs use a discrete number of test sites to monitor the aggregate emissions throughout the watershed, it is important to understand the geophysical dynamics of pollutant transportation in order to understand how these monitoring points may vary from other areas of the watershed (Prabodanie & Raffensperger, 2009). Of particular importance are localised concentrations of pollutants which can occur in discrete parts of the watershed even while the emissions levels of the watershed as a whole remain below the cap set by the NTP. These ‘hot spots’ occur as a result of a disproportionate geographic concentration of polluters in one area of the watershed that either existed prior to the NTP or formed as a result of emission rights trading (Nash & Revesz, 2002:331). The failure to predict such hot spots is accredited for the failure of the first ever NTP programme (Woodward *et al.*, 2002:977)

The complexity of the hydrological system in which an NTP is being implemented critically affects its ability to accurately account for either of these dynamics. Spatial variations in soil, topographic, hydrologic, geologic and landscape features all pose significant challenges (Qiu & Prato, 1999). It is also dependent on the nature of the water body to which it is being applied. NTP can be applied to lakes, ocean, rivers, and groundwater, or any mix of the four. However because of the different characteristics of all four, they each pose discrete complexities to NTPs. Rivers and groundwater are particularly complex as their flow and interaction makes it particularly difficult to determine nutrient loads. Thus a robust understanding of the water body on which it is being applied is as important as that of the way in which nutrients will reach it.

4.5 Social and Political

As a result of the democratic context in which resources are managed in Selwyn District, the success of any policy is dependent on the social and political support it receives.

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Without appropriate buy-in, an NTP could not only lack the necessary support to see it implemented, it could also lack the necessary commitment to see it properly administered. There are two key factors that have proven to influence the support for NTPs.

One important factor is the level to which the general public understands the NTP approach. As Selman *et al.* (2009:15) note, misconceptions resulting from a lack of understanding about the objectives of an NTP often create social and political tensions during their development and implementation. These tensions can result in both the failure to adopt this approach and the failure to successfully implement this approach if in fact it is adopted. To avoid such a scenario requires that all stakeholders, regulators, polluters and the general public have a clear understanding of not only the NTP process, but the benefits and drawbacks of the approach. Familiarity with MBIs in general has been shown to be an important determinant of the existence of this necessary understanding (Markandya, 1998:27). Previous exposure or use of MBI in the wider resources management context is important to ensuring this familiarity.

Another important factor is the political will which exists for deviating from the status quo. As with any new policy, NTP will change the current distribution of rights and resources, creating both winners and losers. Its viability is therefore dependent on the extent to which the affected parties are represented by decision makers (Selman *et al.*, 2009:2). Because existing resource users are typically over represented in democratic processes, their buy in is particularly important (Selman *et al.*, 2009:2; Sinner, Palmer, Fenemor, Baines, & Crengle, 2005:14). It is important to understand the concerns of the affected parties, as well as the political context in which these concerns are mobilized in order to determine whether an NTP will generate the necessary political support to see it successfully implemented.

4.6 Summary

As this chapter demonstrates, there are a number of important variables that impact on the viability of an NTP in any given watershed. Because of the potential costs, both

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monetary and ecologic, of a failed NTP, it is important that these variables be properly assessed in any watershed prior to moving forward with an NTP approach. Figure 4.1 provides a summary of these variables. The following chapter will take this assessment framework and apply it to the Selwyn District of Canterbury.

Table 4.1 Framework for Assessment

<i>Category</i>	<i>Variable</i>	<i>Description</i>
Legal & Intuitional	Existing legal rights system	<ul style="list-style-type: none"> • Does the existing legal rights system accommodate a market in water pollution permits?
	Organisational jurisdiction	<ul style="list-style-type: none"> • Is there a clear delineation of responsibilities within the various relevant authorities?
	Organisational capacity	<ul style="list-style-type: none"> • Is there adequate capacity within the responsible authorities?
Economic	Abatement cost heterogeneity	<ul style="list-style-type: none"> • Is there enough heterogeneity in polluter's abatement costs to allow for gains to be made through trade?
	Market thickness	<ul style="list-style-type: none"> • Are there enough polluters to ensure adequate liquidity in the market?
	Transaction costs	<ul style="list-style-type: none"> • Can transaction costs be appropriately managed?
Biophysical	Nutrient loss and transport	<ul style="list-style-type: none"> • Is there adequate and proven modelling capacity of the watershed to ensure uncertainty is kept to an acceptable level?
Social & Political	Understanding	<ul style="list-style-type: none"> • Is there adequate understanding of the NTP approach?
	Political will	<ul style="list-style-type: none"> • Is there adequate political will to alter current distributions of rights and resources?

Chapter 5 Evaluation of Selwyn District

5.1 Introduction

Despite being a straight forward process in theory, as demonstrated in the previous chapter, there are a number of factors which can play a significant role in determining the viability of an NTP. As the nature of these factors will change from context to context, it is important that prior to the moving forward with an NTP the local conditions be first assessed. This chapter uses the criteria developed in the previous chapter and applies them to Selwyn District to determine the likely viability of an NTP there.

5.2 Institutional and Legal

As discussed previously the viability of an NTP is very much dependent on its ability to operate within the existing institutional and legal frameworks. The Resource Management Act 1991 (RMA) sets the institutional and legal framework for freshwater management in New Zealand and is administered by the Ministry for the Environment. As Sharp (2002) points out, despite the unitary system of government in New Zealand, when it comes to environmental policy and the RMA, New Zealand shares some of the jurisdictional complexities usually associated with federal systems such as those of Canada and the United States.

Freshwater management in Selwyn District is subject to the general planning provisions of the RMA through a hierarchy of documents from national to regional to district level. As a result despite water quality management being the primary responsibility of regional governments, in this case Environment Canterbury, their relevant statutes vis a vis the Resource Management Act and Local Government Act does limit their decision-making capacity regarding the management approach undertaken (Sharp, 2002:53). However in the absence of national policy guidance on freshwater management, regional level policy documents have provided the main freshwater management framework. Through these Regional Policy Statements (RPS) Regional Councils do have the authority to establish the water quality standards essential to the NTP approach.

The legality of the NTP approach in New Zealand is also clear. Sharp (2002) shows that MBIs are given provision under section 5 of the RMA. In fact the RMA requires that economic instruments be considered at both the national as well as regional and local levels as potential instruments to achieve the purpose of the Act. This conclusion is further supported by its current use on the North Island. Waikato Regional Plan variation 5 has successfully demonstrated the use emission trading approach under the RMA to counter the pollution problem in the Lake Taupo catchment (Rutherford & Cox, 2009:13).

There does however appear to be a significant capacity deficit at lower levels of government. A 2010 review of Environment Canterbury by a group of some of New Zealand's most experienced assessors of organisational capability found a significant gap between water management needs in the region and Environment Canterbury's capacity to carry them out (Creech *et al.*, 2010). This review concluded that Environment Canterbury's capacity on water policy, including water quality management, falls well short of what is essential (Creech *et al.*, 2010). This capacity deficit could be critical in determining its viability given that the NTP approach requires significant resourcing in its infancy.

5.3 Economic

Appropriate economic conditions are important for ensuring that adequate incentive exists for polluters to voluntarily participate in an NTP. Abatement costs heterogeneity, market thickness and transaction costs are three important variables affecting this condition.

There are two factors affecting a polluter's abatement cost: the impact that any abatement effort will have on their emissions; and the economic costs associated with that action. Despite Selwyn District being a relatively small geographic area, weather stations scattered throughout the District show the existence of a number of microclimates. For example, Darfield receives on average 68% more rain than Lincoln in a year (Cross, Dalziel & Saunders, 2004:25-26). Such variations in precipitation have been shown

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significant impact on levels emissions transported off a paddock. There are also a number of different types of soil and a range of slopes through Selwyn District (Cross *et al.*, 2004:21), each of which has a specific impact on mitigation efforts. As demonstrated in Waikato, this variation can have a significant impact on the abatement costs heterogeneity (Ramilan & Scrimgeour, 2006).

Abatement costs are also dependent on the polluter production cost function. Table 5.1 provides a breakdown of the types of farming conducted in Selwyn District. It highlights 25 different types of farm. While the production functions for each type are not known, it is reasonable to assume that amongst this wide range of farming types there is likely to be some diversity in costs structure. Ramilan and Scrimgeour (2006) also highlight that the nature of this heterogeneity is likely to change relative the specific abatement level sought. The implications of this are that as the cap evolves there is likely to be a continual incentive to trade credits and therefore ensure economic efficiency over the longer term.

Table 5.1 Break-down of Selwyn District Farming

<i>Farm Type</i>	<i>Number of Farms</i>	<i>% of Total Farms</i>
Sheep Farming	500	22.7
Beef Cattle Farming	290	13.2
Horse Farming	180	8.2
Dairy Cattle Farming	170	7.7
Deer Farming	100	4.5
Grain-Sheep and Grain-Beef Cattle Farming	60	2.7
Sheep-Beef Cattle Farming	60	2.7
Livestock Farming	50	2.3
Pig Farming	40	1.8
Mixed Livestock	40	1.8
Poultry Farming (Meat)	18	0.8
Poultry Farming (Eggs)	9	0.4
Vegetable Growing	140	6.4
Other Fruit Growing	80	3.6
Plant Nurseries	40	1.8
Cut Flower and Flower Seed Growing	35	1.6
Grape Growing	25	1.1
Apple and Pear Growing	25	1.1
Berry Fruit Growing	15	0.7
Kiwi Fruit Growing	3	0.1

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Grain Growing	60	2.7
Cultivated Mushroom Growing	6	0.3
Crop and Plant Growing	40	1.8
Forestry	110	5.0
Other	35	1.6
Total Farmers	2,200	100

Source: Cross, Dalziel & Saunders (2004)

Market thickness also plays an important role determining NTP success. In an ideal market, participants would be able to buy and sell allowances when they wished without affecting the market price (Lock & Kerr, 2008:4). As highlighted again in Table 5.1, there are 2,200 farms operating in Selwyn District (Cross *et al.*, 2004). Evidence from successful Nutrient Trading Programmes in the United States such as that at Chesapeake Bay, suggest this is sufficiently large to see the existence of a competitive market in nutrient credits (Wiedemand, 2001).

Transaction costs are a third economic factor affecting the viability of an NTP. Central market amalgamators are one means which has successfully minimized transaction costs in NTPs. Central market amalgamators are agencies that control the trading of shares and reduces the effects of bilateral trades on cost effectiveness (Atkinson & Tietenberg, 1991:28). The feasibility of such an approach in New Zealand has been demonstrated by its use in the Lake Rotorua Nutrient Trading Program. Their effective application in Selwyn District has also been demonstrated through local level modelling of various emissions trading schemes (Prabodanie & Raffensperger, 2007).

5.4 Biophysical

A key requirement for the tradability of emissions a permit is the ability to relate a polluter's management practice to both the emissions from their land and to the impacts those emissions have on the water quality downstream. This ability is dependent on the capacity to accurately account for both nutrient loss as well as nutrient transport within the catchment, which is in turn affected by the geophysical complexity of the watershed.

New Zealand's AgResearch has developed a nutrient budgeting model to facilitate the estimation of nutrient losses from pastoral lands called Overseer (Selman *et al.*, 2009:14; Ramilan & Scrimgeour, 2006:5). This model provides users with a tool to examine the impact of various management techniques on both production costs as well as leaching rates (AgResearch, 2010). In doing this it is able to quantify the emissions reductions of various management practices. While Overseer has been shown to offer considerable insight into the land management nutrient loss relationship, it has none the less proven to remain imperfect (Chichota & Snow, 2008). As a result, there remains uncertainty regarding the accuracy of the environmental and economic significance of changes in management practices.

The hydrological dynamics of the water shed as a whole also remain a significant uncertainty in Selwyn District. Seepage from Rakaia and Waimakariri rivers into Selwyn District's watersheds, along with the dynamic and complex interaction existing between ground and surface water, blurs the lines between different cause and effect relationships. As a result, the ability of an NTP to take into account the possible development of hot spots within the watershed is limited. While biophysical uncertainty is a reality for all NTPs, the specific conditions of Selwyn District present a particularly significant barrier to creating the confidence needed to operationalize an NTP.

5.5 Social and Political

The social and political context of resource management is a final important variable influencing the viability of an NTP. The current social and political context of water management in Selwyn District is complex and variable. As a result, the likely impact it will have on NTP success is difficult to determine.

There is evidence to suggest a familiarity with MBIs in resource management amongst both decision makers and the public. Their high profile application to marine fisheries in the 1990's is perhaps the most well known, however there exists a wide range of use from the auctioning of oil and gas exploration rights to the trading of water takes. While its application to water quality is novel in Selwyn District, because of their application to

other resource management issues it would be reasonable to expect at least a basic familiarity with the principles of the approach.

Despite this general familiarity administrators remain reluctant to embrace MBIs. The requirement of their assessment under Section 32 of the RMA does not seem to be sufficient incentive for the serious consideration of their application. Sharp (2005:57) points out that this is likely the result of the prevailing regulatory culture in regional government. Because of both a familiarity and an established process, CAC remains the favoured instrument and is often selected without comparative analysis. It is also likely related to the limited local capacity highlighted earlier. Already stretched too thin, it is not likely that a regulatory organisation will be interested in taking a chance with a novel approach unless its effective use is certain to produce significant advantages.

This reluctance by administrators to take on an NTP approach is only worsened by the highly charged political context of water management in Canterbury (Lomax, Memon & Painter, 2010). Because of the local level administration, local interest groups are likely to have a greater impact on decision making. Furthermore, because of the relative size of the agricultural sector within the local economy there is likely to be more focussed influence because of reduced heterogeneity of interests (Sharp, 2002:39). There is however evidence that this may be changing. A recent review of the Canterbury Water Management Strategy suggests that it has been successful in laying a broad strategic foundation for reaching agreement on contentious water issues. However it also highlights that while this progress is significant, it remains a fragile process (Lomax, Memon & Painter, 2010).

5.6 Summary

Figure 5.2 provides a summary of the findings highlighted above as they related to the evaluation criteria developed in chapter four. While there is a clear lack of capacity to implement an NTP and there remains some uncertainty surrounding the accuracy of current biophysical modelling as well as a fair bit of political volatility the remaining six variables seem to be well supported. In order to build a more conclusive picture of the

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significance of these observations, the following chapter will discuss these findings in context of recommended future steps.

Table 5.2 Assessment results

<i>Category</i>	<i>Description</i>	<i>Finding</i>
Legal & Intuitional	<ul style="list-style-type: none"> • Does the existing legal rights system accommodate a market in water pollution permits? • Is there a clear delineation of responsibilities within the various relevant authorities? • Is there adequate capacity within the responsible authorities? 	<ul style="list-style-type: none"> • Yes • Yes • No
Economic	<ul style="list-style-type: none"> • Is there enough heterogeneity in polluter's abatement costs to allow for gains to be made through trade? • Are there enough polluters to ensure adequate liquidity in the market? • Can transaction costs be appropriately managed? 	<ul style="list-style-type: none"> • Yes • Likely • Likely
Biophysical	<ul style="list-style-type: none"> • Is there adequate and proven modelling capacity of the watershed to ensure uncertainty is kept to an acceptable level? 	<ul style="list-style-type: none"> • Uncertain
Social & Political	<ul style="list-style-type: none"> • Is there adequate understanding of the NTP approach? • Is there adequate political will to alter current distributions of rights and resources? 	<ul style="list-style-type: none"> • Yes • Uncertain

Chapter 6 Conclusions

6.1 Introduction

The previous analysis highlights some mixed results regarding the viability of an NTP in Selwyn District. While some variables clearly support an NTP, the state of others remains uncertain. This chapter will discuss these findings and make recommendations regarding moving forward with an NTP in Selwyn District. It will also highlight a few areas in which future research could add significant value to existing understandings.

6.2 Recommendations

The recommendations draw on the findings from the previous chapter and are intended to direct efforts to NTPs in Selwyn District.

6.2.1 Build Local Capacity

While water quality management in Selwyn District is subject to a hierarchy of jurisdiction as laid out in the RMA, because of the absence of national level direction, responsibility is clearly understood to rest with Environment Canterbury. The current application of NTPs to the water quality management in at least two watersheds in New Zealand clearly demonstrates its legality. Both of these findings offer strong support for the possibility of an NTP to operate within the legal and institutional framework of New Zealand's fresh water management.

Despite this clear demonstration of its possibility, due to a lack of resources at the regional and local levels its feasibility is less clear. This lack of capacity calls into question the ability of regional and local councils to develop and implement an NTP and their ability to provide the necessary monitoring and enforcement to see the system operate effectively. NTP viability is limited without this capacity.

Despite this observed weakness at the local level, there is a demonstrated strength at the national level as well as within other regions. The successful implementation of an NTP in both the Lake Taupo and Lake Rotarua watersheds suggests that it is possible for the

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necessary capacity to exist at the regional and local levels. Unlike many other factors affecting the viability of an NTP, institutional conditions have the potential to be changed through targeted efforts. Rather than a permanent impediment to NTP use, this capacity deficit can be viewed as an indication of where effort should be focused prior to NTP development. Given the recent uncertainty regarding the organisational structure of Environment Canterbury and the proposed development of a separate water management body, there is considerable opportunity for this capacity to evolve in a short period of time.

In order to ensure that this capacity is built it is recommended that efforts be targeted on learning from existing national level expertise, as well as from other local level expertise. While resourcing is also a fundamental component of capacity, developing a better local understanding of the administrative requirements of an NTP would help inform and justify future resourcing efforts. Learning from regional and local councils which have already implemented NTPs under similar organisational constraints is therefore fundamental.

6.2.2 Develop Experienced Understanding

The above analysis finds that the economic prerequisites of an NTP are currently met within Selwyn District. Evidence on abatement costs heterogeneity, market thickness and transaction costs all suggest that an NTP will offer the potential economic gains needed to encourage emitters to participate in voluntary exchange under a cap. However, unlike other variables, economic conditions can be significantly altered by the design of the NTP. Therefore while these preliminary findings are positive and should not be discounted, there needs to be sufficient attention paid to the design and implementation of the NTP to ensure these conditions are optimized.

One aspect which needs to be considered is the scope of polluters included under an NTP. The scope can range from including only one specific type of nutrient emitter, such as dairy farmers, to including all possible sources. Previous NTP experience has demonstrated that while the flexibility and efficiency of the system will increase with the

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more polluters the policy covers, so too will the administrative costs (Lock & Kerr, 2008:5). Therefore, because any gains expected to come from this more inclusive structure are subject to higher transaction costs, it is recommended that there is a careful consideration of the cost and benefit of alternative scopes.

A second important design consideration with respect to ensuring that adequate economic incentives persist is the mechanism through which emissions credits are exchanged. Online market amalgamators have demonstrated success in reducing transaction costs in a number of settings including in Selwyn District. However the structure that creates the most efficient market may not provide the highest certainty that environmental targets will be reached. Therefore, there must be a conscious and well justified evaluation of the tradeoffs.

While there is a lot to be learned from how NTPs elsewhere have addressed these trade offs, because of the importance of local conditions on all aspects of the market structure it is recommended that any NTP development in Selwyn focus on building from local understandings. In order to do this localised pilot sights should be run to test alternative market structures. Lessons learned from these small scale applications can then be drawn on to inform structuring these trade offs at the catchment level.

6.2.3 Minimize than Mitigate Uncertainty

Geophysical uncertainty presents the most significant challenge to the viability of an NTP in Selwyn District. The complexity of interaction amongst water bodies in the watershed limits the accuracy of both emissions and transport modelling. This uncertainty can have a considerable impact on the economic and ecological confidence of the system.

Though varying in degree, this uncertainty is a condition facing all NTPs throughout the world. This uncertainty is most commonly internalised into the trade by building trading ratios into all emissions credit transactions. Rather than allowing one to one trading, a polluter must purchase more credit than that which is being sold. For example in order to increase ones emissions by 10 units, 12 units would need to be purchased from other

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emitters. Such trading ratios are particularly important with regard to new and innovative mitigation measures as their true value has often not yet been fully demonstrated. Therefore as they gain acceptance and develop a degree of scientific certainty, the trading ratio they are subject to can be reduced. While these trading ratios help address some of the ecological uncertainty, they do increase transaction costs. Therefore, once again level of ecological certainty needs to be measured against the economic cost of achieving it. Furthermore, not all types of trades have the same level of uncertainty and therefore should not all be subject to the same ratio.

In order to achieve the optimal environmental and economic outcomes it is recommended that the NTP mechanism include a classification of uncertainty based on the location of the polluters, the type of emissions they are discharging and the abatement measures they are introducing. To do this will require further development of the current modelling capacity in the District. It will also, however, require building more localized understandings of the various biophysical characteristics throughout the watershed and their likely effects on emissions and transportation. New Zealand's National Institute of Water and Atmospheric Research is already conducting similar localized testing (NIWA, 2010), however in order to meet the needs of a District wide NTP these efforts will need to be better resourced and more widely applied.

6.2.4 Build on Participatory Framework

Familiarity with MBIs might suggest a certain level of social and political acceptance with the approach, however because of the politically charged nature of water management in Selwyn District such familiarity does not necessarily translate into its desirability. Because an NTP will change the current distribution of rights and resources it is inevitable that there will be some political aversion. Given the traditionally adversarial approach to resource decision making in the district the effects of this aversion could be significant.

There is also, however, emerging evidence that this may be changing. With a new organisational structure and associated mandate at the regional level as well as with the

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emergence of a new participatory approach to water management decisions, there is reason to believe that positive change can occur. As Atkinson and Tietenberg (1990:30) point out, it must also be recognized that virtually all regulatory reform goes through stages. Through these stage expectations and beliefs will fluctuate. Therefore it is important that any effort to develop and implement an NTP recognizes this volatility in the political and social landscape and that these efforts take a long term perspective and see beyond the problem of the day and seek lasting substantive solutions.

With the long run in mind it is recommended that any development of an NTP work within the emerging participatory framework. The value of such an approach has been previously demonstrated in New Zealand through the ITQ process which established early collaboration between government official and industry representatives to allow for concerns from all stakeholders to be heard and considered in the design (Sinner et al., 2005:5).

It is also recommended that an NTP be implemented through a series of limited duration, limited geographic extent pilot projects. Not only does this build on previous recommendations but such an approach can reduce the perceived threat of changes by allowing individuals to gain some degree of comfort with the production modification required before there are serious sanctions for non-compliance. They also allow for a greater familiarity with the mechanism to develop prior to any real costs or consequences being enforced. This familiarisation will not only help the polluters adjust, but will also help the local council develop a better understanding of the programme and its requirements.

6.3 Future Research Directions

In providing a preliminary overview of the likely challenges an NTP will face in Selwyn District, this dissertation also highlights some areas in which more research is needed. The following draws on these and makes specific recommendations for future research in the field.

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6.3.1 Establishing Potential Economic Gains

While this dissertation concluded that economic conditions were conducive for an NTP, the analysis could none the less benefit from a more focused survey of abatement cost heterogeneity within the district. This work would provide a more definitive quantification of the likely economic gains to arise for the mechanism and would therefore help build the political will for such a system as well as to reduce some of the uncertainty held by the practitioners responsible for its implementation.

6.3.2 Determining a Cap

Currently there is limited understanding of what a nutrient cap in the district might look like. This requires not only a better understanding of the ecological thresholds but also the social and cultural preferences. Developing a better understanding of what a cap might look like and building an evidence base around it will increase the social acceptance and political will needed for an NTP to contribute to water quality management goals.

6.3.3 Targeted Hydrological Modelling

While modelling will never eliminate uncertainty and this field of knowledge is likely to be one that continues to evolve, there needs to be a more concentrated effort to look at the current biophysical understandings and how they relate to the needs of an NTP. This means more targeted research on the specific modelling needs of an NTP. This involves taking a better account of the limitations to the current modelling, noting the impacts that these limitations have on the system and then focusing efforts on addressing these. This would include a better understanding of differences in uncertainty within the watershed.

6.4 Conclusion

The analysis conducted here highlights the overall viability of an NTP in Selwyn District. Legal, economic and social conditions are all conducive to its adoption. While institutional, biophysical and political factors do highlight some potential obstacles, there is sufficient evidence from NTPs elsewhere that through the execution of the recommendations provided here, these obstacles can be successfully overcome.

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Despite demonstrating the viability of an NTP in Selwyn, this analysis does not necessarily imply its desirability. While it has demonstrated a suite of potential economic, ecological and political benefits associated with the approach, the ultimate decision about its adoption should remain to be determined by those affected, the people of Selwyn District. Neutering the emerging participatory approach to resource management should therefore be a fundamental goal of Selwyn District, regardless of whether an NTP is adopted.

It should also be noted that the successful adoption of an NTP will not necessarily be a fast process. Because of the effects of local conditions, every NTP needs to be catered to its context. As a result the success of an NTP in Selwyn will in part depend on its ability to internalize lessons over time. It would be wise for process of implementation to therefore be designed with this in mind. Starting with small scale localized deployment before moving to larger more consequential applications.

NTP success will also depend on its effective integration within the larger resource management framework. Despite being a new tool, it none the less needs to become part of a larger tool box. Viewing NTPs a stand alone solution will likely result in grave disappointment. It needs to be understood by all stakeholders that NTPs need to be but one component of a larger integrated solution.

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