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THE QUANTIFICATION OF INDIRECT BENEFITS FROM FLOOD PROTECTION IN THE LOWER WAIKATO

A Thesis submitted in partial fulfilment of the requirements for the Degree of Masters of Applied Economics at Massey University, New Zealand.

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Abstract

Flood protection schemes provide a wide range of benefits to people living in the immediate floodplain area and to those living further away from the floodplain area. Since such schemes are public goods, they are often provide and managed by the government or local bodies. According to the Local Government Act (No.3) of 1996, the community based funding of such works are to be allocated purely according to benefit received. In other words, those who benefit from the works are required to contribute towards the costs of the works, in proportion to the benefits they received. Hence the need for the quantification of benefits.

The Rating Powers Act of 1988 requires the rating of flood protection schemes to take into account direct and indirect beneficiaries. In this research the aim was to quantify the indirect benefits from flood protection in the Lower Waikato, using the non-market valuation technique of Contingent Valuation. In particular the study focused on the indirect beneficiaries of the Lower Waikato Waipa Flood Control Scheme (LWWCS). A total of 800 households in the indirect benefit area of the LWWCS were sent a mail questionnaire to elicit their willingness to pay for indirect flood protection. A return rate of 31 percent was obtained.

The results obtained indicated that 56.8 percent of the respondents perceived to benefit from the LWWCS, and 65.3 percent respondents believed that flood protection was worth paying for. The dollar value allocated to indirect flood protection in the Lower Waikato was estimated at $21.40 per year per household.

Acknowledgements

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Introduction

1.0 Introduction

Flood protection schemes are public goods from which society derives a wide range of benefits. Such goods have the characteristics of being non-excludable and non-rivalous. This means that no one can be excluded from thier use and the use by one individual does not affect the use of another.

The benefits from flood protection schemes accrue to everybody living in the floodplain area, irrespective of whether they have contributed to the cost of providing the scheme or not. It is for this reason that flood protection schemes are not provided by the market but by some central or local authority that can extract payment from all those affected.

Once in place, flood control schemes provide benefits to those in the floodplain area in terms of avoided flood damage, however others living in close proximity to the flood plain who are not directly threatened by floods also benefit from the scheme. These people benefit if their access to towns, work, hospitals and schools runs through the floodplain area. Further people in the wider region also benefit from an increase in economic activity due to the presence of the scheme. It is these indirect beneficiaries who are the focus of this thesis.

The Lower Waikato Waipa Control Scheme (LWWCS) is a major flood control scheme instigated by the Waikato Regional Council (Environment Waikato). The scheme is designed to provide protection and drainage improvements within the flood plains of the Lower Waikato and Waipa Rivers. Scheme construction was commenced in 1961 and completed in 1982 at a total cost of some $135 million in today's values. The scheme primarily consists of stopbanks, pumpstations, floodgates, and main river channel improvement works. The indirect beneficiaries of the LWWCS are the main focus of this study.

1.1 New Zealand Legislation

1.1.1 The Resource Management Act 1991

In New Zealand the primary legislation that controls environmental effects is the Resource Management Act 1991 (RMA). Its purpose is to promote the sustainable management of New Zealand's natural and physical resources. This includes avoiding or mitigating any negative effects on the environment. The purpose and principles are set out in Part II of the Act (see Appendix 1).

Section 30 of the RMA sets out the functions of Regional Councils under the Act. In particular, subsection (1)(c)(iv) focuses on the avoidance and mitigation of natural hazards. It states:

> S30. Functions of regional councils under this Act-
> (1) Every regional council shall have the following functions for the purpose of giving effect to this Act in its region:
> (c) The control of the use of land for the purpose of-
>
> (i) Soil conservation:
> (ii) The maintenance and enhancement of the quality of water in water bodies and coastal water:
> (iii) The maintenance of the quantity of water in water bodies and coastal water:
> (iv) The avoidance or mitigation of natural hazards:
> (v) The prevention or mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances.

As this directly relates to the purpose of the Act, the construction and maintenance of flood control schemes clearly become a responsibility of the Regional Council in achieving the purpose of the Act. To help the council achieve this, the Local Government Amendment Act sets out the funding principles.

1.1.2 The Local Government Act (No.3) 1996

The Local Government Act No.3 (LGA), in particular Section 122F, addresses the principles in respect of community based funding, beneficiary contributions, and contributory or exacerbator contributions (see Appendix 2).

The development of funding systems under the LGAA is a three-step process. The three steps can be summarised as:

1. Allocate costs purely according to benefit and contribution.
2. Modify cost allocation taking into account the interests of residents and ratepayers, fairness and equity, Council policies, and avoidance of significant adjustments.
3. Consideration of the extent to which it is practical and efficient to fund expenditure in a way that achieves the modified cost allocations arrived at step two.

1.1.3 Rating Powers Act 1988

The Rating Powers Act 1988 (RPA) provides Environment Waikato with a specific mechanism for rating drainage and river protection. Section 41 of the Act sets out the matters that are to be taken into account in respect of direct and indirect benefits. This includes consideration of the extent to which the characteristics or the use of any property or actions of the occupier are likely to contribute to or alleviate the need for the work or service provided. It states:

S41 Differential rates -

(1) In adopting a differential rating system in terms of section 79 to 93 of this Act in accordance with section 40(3) of this Act, a Board shall take account of -

(a) The benefits that are, in the opinion of the Board, likely to accrue, directly or indirectly, to any property from the work or service in respect of which the separate rates are to be made; and

(b) The extent to which the characteristics or the use of any property, or any actions of its occupier, are, in the opinion of the Board, likely to either contribute to or alleviate the need for the work or service concerned.

The combined effect of the respective sections of the Local Government Act (No.3) and the Rating Powers Act are that the differential rating system should take account of direct benefit, indirect benefit, and contributory or exacerbatory matters.

1.2 Objectives of research

The purpose of this research is to find a methodology that will help decision-makers identify and quantify the indirect benefits from flood protection. The results of this research can then be used in the allocation of yearly maintenance costs among the direct and indirect beneficiaries of the LWWCS.

The specific objectives of the research are:

1. To select an appropriate method for evaluating the indirect benefits from the LWWCS.
2. To gather peoples opinions and attitudes towards paying for flood control in the Lower Waikato.
3. To place a dollar value on flood protection to the indirect beneficiaries.
4. To provide information to determine the most significant factors influencing this value.

1.3 Methodology

This study focuses on the identification and quantification of indirect benefits from flood protection in the Lower Waikato. Since goods and services such as protected road access and peace of mind are not traded in the market, there is no market valuation of their worth to society. Alternative means need to be employed to value these goods and services. It is through the non-market valuation techniques that we set out to value their worth.

Since public funds are used to finance public projects which lack market values, non-market valuation approaches this problem either of two ways:

(i) observe peoples revealed preferences for substitute or complement marketed goods

(ii) elicit people's preferences using a stated preference technique.

1.4 Importance of research

- This research will contribute to the decision making process of the Waikato Regional Council and to the general field of resource evaluation research.
- It will aid decision-makers in the identification and estimation of indirect benefits from flood protection schemes, which will in turn help allocate the yearly maintenance costs from such schemes among the direct and indirect beneficiaries.

1.5 Thesis outline

In Chapter two, a discussion of the economic theory behind non-market valuation and its various techniques are presented. In particular the Contingent Valuation Method is discussed in detail. Reasons why the Contingent Valuation Method was chosen as the appropriate technique for this study are explained.

Chapter three provides some background information about the Lower Waikato area in general and the indirect benefit areas of the LWWCS. It also presents some information regarding the LWWCS.

In Chapter four, the research methodology is discussed. The identification of benefits from the scheme, survey design and method, questionnaire design and implementation are explained.

Chapter five presents the responses of the survey. The statistics compiled from the survey are presented and explained.

In Chapter six, the Dichotomous Choice format of Contingent valuation and the Logit model are explained. The logit model is then applied to the data collected to derive the dollar value for indirect flood protection in the Lower Waikato.

Chapter seven concludes by summarising the study. It explains how the objectives of the study have been satisfied and presents the limitations of the methodology. Recommendations based upon the findings are then presented.

1.6 Summary

This chapter has outlined the presence of the LWWCS, the issues associated with the financing of a public good and the legislation in New Zealand regarding the funding of such works and services. According to the Local Government and Rating Powers Acts, those who benefit from the presence of such works are required to pay towards the yearly maintenance of the scheme based on how much benefit they receive. Therefore, in order to charge the beneficiaries equitably, we must be able to quantify the amount of benefit they receive. For this purpose, in the next chapter we set out to select a non-market valuation technique whereby we can estimate the benefits received by the indirect beneficiaries of the LWWCS.

Chapter 2

Theoretical Foundations for Estimating the Indirect Benefits from Flood Protection

2.0 Introduction

The investment of money in a flood protection scheme implies a reallocation of land, labour and capital resources. In making this reallocation the products produced by these resources may be lost, but other benefits will be gained through the new allocation of resources. In a society that seeks to maximise its welfare, it is important that such a resource reallocation results in net benefits.

The ranking of different resource allocations requires the making of value judgements, i.e. is the allocation better or worse? Welfare economics helps in formulating principles and tools with which to achieve maximum welfare through making comparisons. One crucial element in the process is an estimation of the benefits associated with different resource allocations. In this chapter the theoretical foundations for benefit estimation will be discussed and the principles and tools explained.

2.1 The Economic Concept of Value and Resource Allocation

To economists, the term "value" has a very specific meaning. The most important but often overlooked feature of economic value is that it is a theoretical construct and that monetary measures of economic value are inferred by analysts from the choices that individuals make. Economic value cannot exist independent of a choice (Kopp, Pommerehne & Schwarz, 1997).

The economic concept of value employed here has its foundations in neo-classical welfare economics. The basic premises of welfare economics are that the purpose of economic activity is to increase the well-being of the individuals who make up the society, and that each individual is the best judge of how well off he or she is in a given situation. Each individual's welfare depends not only on that individual's

consumption of public and private goods and services, but also on the quantities and qualities each receives of non-market goods and services that derive from natural resources and the environment, for example, health, visual amenities and opportunities for outdoor recreation. The basis for deriving economic value of changes in environment is their effect on human welfare (Freeman, 1993).

Standard economic theory for measuring changes in individual well-being was developed for the purpose of interpreting changes in the prices and quantities of goods purchased in the markets. This theory has now been extended to public goods and other non-market services such as environmental quality and health.

A fundamental objective of a democratic society is to maximise total welfare, but whether or not welfare is actually being improved is often difficult to ascertain. It will depend on the utility or satisfaction that individual members of society are attaining. This utility is often less than satisfactorily measured in monetary terms to allow a quantitative indication of welfare change. The justification for the use of monetary measures is that they reflect something about the economic well-being of individuals and that the welfare of society is in part dependant on the utility derived through consumption (or economic well-being). Accepting that consumers are the best judge of what is valuable to them, benefits received will be reflected in the price they are willing to pay for a particular good or service (Harris, 1983).

The provision of a public good is often not controlled by the market system. The commodity is 'unpriced' because of certain characteristics such as joint consumption and non-excludability. The government performs the task of providing public goods, usually free of charge; hence no consumer valuation in terms of market prices is available. To determine an optimal level of provision the government needs to know what value society places on a particular public good and what the costs are in providing and maintaining it.

Economic theory assumes that welfare will increase if the benefits are greater than the costs, and certain conditions of welfare economics which relate to income distribution, the correctness of the present distribution, optimal levels of production and the exchange and production of goods in a competitive market are fulfilled. If the

magnitude of the benefits and costs are not significantly large then the welfare economic conditions are assumed to be satisfied. In such a situation an efficiency criterion can be applied to the relationship between the benefits and costs to ensure that society's actions take it closer towards a welfare optimum.

Kaldor (1939) and Hicks (1940) proposed such a criterion for evaluating public policies and projects. This is the Kaldor-Hicks compensation principle, otherwise known as the potential Pareto improvement. If those who would gain from a proposed change could compensate those who would lose, to the full extent of their perceived losses, the change would be acceptable. As long as those who gain can compensate those who lose and still benefit from the change, a policy or project satisfies the criterion. Actual compensation is not required. If it were, then the proposal would satisfy the strict Pareto criterion.

2.2 Public Goods and Market Failure

The marketplace is the most efficient way of producing private goods. However for the market to achieve this efficiency in resource allocation, it needs to have well defined property rights for all resources, predictability, safety, nomenclature among others. If these do not exist the market may fail to achieve efficient resource allocation. In the case of public goods benefits cannot easily be confined to a single "buyer" or set of buyers. Yet once they are provided, many can enjoy them for free, for example, flood protection.

An environmental asset is considered a public good if its consumption is non-excludable and non-rival (Hanley, Shogren & White, 1997). "Non-excludability" refers to the impossibility of preventing non-paying individuals from enjoying the benefits of a good or service; the item is used to characterise an externality. Without a mechanism for collective action, these goods can be underproduced (Kaul et al., 1999). A lighthouse is a classic example of a non-excludable public good. Each shipping company owner knows that if another shipping company erects a lighthouse, it will effectively serve his ships as well. Thus each ship owner will likely try to shirk paying his share of the costs and thereby "free ride" off the efforts of others. Even if the benefits of a lighthouse would exceed the costs, the market may not provide it,

because there is no way of excluding non-payers from enjoying those benefits. Thus, markets will underproduce goods and services whose provision would entail positive externalities. Likewise, goods and services whose provision would entail negative externalities will be overproduced in the presence of transaction costs.

"Non-rivalrous consumption" refers to cases wherein an individual's ability to consume a good or service is not diminished by allowing additional individuals to consume it. This implies that the marginal social cost of supplying the good to an additional individual is zero. The example of the lighthouse can be used again here as being non-rival, as the use of the lighthouse by one person or boat does not affect its use by another person or boat.

In the case of a flood control scheme, the benefits it provides in the form of reduced flooding of land and property, protection of roads and communication lines, improved environmental quality, peace of mind among others, are available to everyone. Nobody can be excluded from enjoying them and use by one person does not prevent the use by another. In a similar sense the negative externalities generated by inadequate flood protection are also a public good. A lower level of flood protection for one person does not prevent another person experiencing that same lower level of protection, and people in the community cannot avoid that lower level of protection. The appropriate level of the public good determines the appropriate level of effects, and vice versa.

Even though the free market may not be able to provide a public good, if it is to be provided, it should be supplied in an efficient way. The provision of public goods and services by central and local authorities should lead to a Pareto improvement. To achieve this improvement, authorities need to have information on the benefits and costs of public goods and services. For private goods traded in the market, the area under the demand and supply curves provides that information. However, for goods not traded in the market no such information is available. The techniques developed to measure the benefits of such non-market goods are called non-market valuation techniques. They are designed to measure the consumers' surplus associated with the consumption of non-market goods.

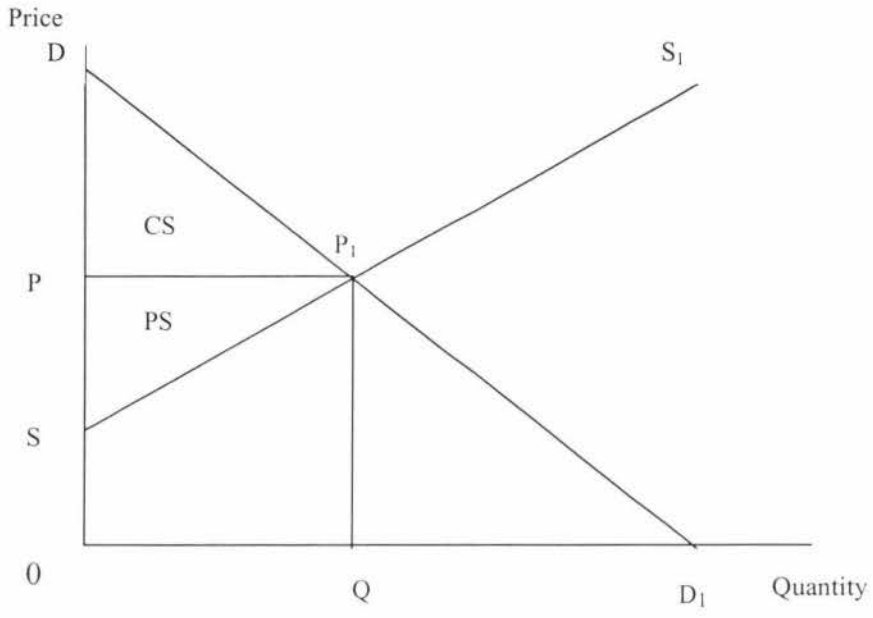
2.3 Consumer Surplus and Benefit Estimation

Consumer surplus is a measure of the net benefit received by individuals in their consumption of some commodity. That is, it is the amount in excess of market price which consumers would have been willing to pay, but which, at the prevailing market price they are able to retain (Australian Department of Finance, 1993). The surplus received by a consumer is the difference between the price that he or she would be willing to pay for the commodity (equal to the benefit he or she receives from it), and the price that is actually paid for it (the costs incurred in obtaining the commodity).

The price a consumer is willing to pay in monetary terms for a good is assumed to be equal to the value that he or she perceives the good to have. A consumer will not be prepared to give up more than can be gained from consuming a particular good. Thus we can think of an agent's demand curve for a particular good as being equal to the marginal utility gained from consuming the particular good.

The consumer demand curve reflects how much consumers are willing to consume of a product at different prices while the producer supply curve reflects how much producers are willing to supply of a product at different prices. The total satisfaction of the consumer is represented by the entire area under the demand curve. Therefore, the area of the demand curve which lies above the price actually paid is the consumer surplus, indicating the excess of what the consumer would have been willing to pay over what he or she actually had to pay. Producer surplus is the area above the supply curve below the market price. The net social benefit is the sum of consumer and producer surplus.

Figure 2.1 Consumer Surplus



*Source:*Bann, 1998

In figure 2.1, D - D_1 represents the demand curve indicating what the demand for a good would be at different price levels (i.e., consumer's willingness to pay for the good or service in question). Generally, demand is inversely related to price, i.e. as price increases, demand falls. S-S_1 represents the supply curve, indicating how much of a good will be supplied at a given price. Generally, supply is positively related to price, i.e., as price increases, so does supply.

The value of an environmental good or service is therefore equal to the market value (P*Q) plus the consumer surplus (D-P_1-P). Strictly, the demand curve traces out the willingness to pay (WTP) for extra (or 'marginal') amounts of a good or service. The demand curve is therefore a 'marginal willingness to pay' schedule. The marginal cost, or marginal benefit, is the change in total cost or benefit from an increase or decrease in the amount supplied or used. Changes in consumers' (and producers') surplus are used to measure gross welfare effects.

The area D-P_1-P represents the Consumer Surplus. In practice, the area D-P_1-P is often irregular due to the non-linear shape of the demand curve. To be truly accurate, estimation of consumer surplus would generally need to be done algebraically. By evaluating the demand curve and observing the behaviour of a particular consumer,

we can obtain a numerical measure of the welfare impacts due to changes in the economy on the consumer. The correct measure of value is the individual's maximum willingness to pay to prevent environmental damage or realise an environmental benefit (represented by the area under the demand curve) (Bann, 1998).

Non-Market Valuation is a means of establishing the value of some item for which no organised market currently exists. For example; there is no market in place by which we might recognise the worth of public telephone booths. However, such services certainly have a value in the eyes of those who use them. Non-market valuation ascertains how people value a commodity for which they have no mechanism of paying.

The role of non-market valuation, is in deriving demand functions that cannot be explicitly observed in the marketplace. To have any type of understanding about the effect on the welfare of an individual or a society we must have knowledge of the preferences of that individual or society. We must understand how changes in a commodity's price or availability will affect welfare if we are to maximise that welfare subject to our policy tools.

2.3.1 Estimation of Consumer Surplus

There are two main approaches to Consumer surplus that have arisen. The first by Alfred Marshall in 1920, and the second by John Hicks in 1941. Marshall believed that the best way to judge the welfare impacts of an event was to consider the effect it had on an individual's utility level. An individual's utility is given as some function of their consumption of a commodity. That is:

$$U = U(x_1)$$

Marginal utility is then given by the first derivative with respect to x_1:

$$MU = \frac{dU(x_1)}{dx_1}$$

Where;

$$\frac{dU}{dx_1^2} > 0 \qquad \text{and} \qquad \frac{d^2U}{dx_1} < 0$$

This means that the utility a consumer derives from a commodity is positive and increasing but at a decreasing rate. Alternatively, our utility function is concave in x_1.

The utility approach, while very elegant, is of little practical use. The reason for this is simply that utility cannot be directly observed. Since we are not able to observe an agent's utility level, we cannot observe his or her utility function and thus cannot evaluate the welfare impacts.

Marshall (1920) took the next step from this seeming stalemate by making a crucial assumption. He proposed that money be used as an indicator of utility and that the individual's demand curve be accepted as a proxy for the marginal utility curve. Changes in consumption behaviour indicate a change in welfare that can be measured by examining the area under the demand curve. Marshall's assumptions, however, were ambitious to say the least. His assumption of money representing utility implies a constant relationship between the two. That is, Marshall assumes that the marginal utility of money is constant with respect to prices and income.

The notion of cardinal utility i.e., utility measurement that assigns importance to the actual magnitude recorded is, in itself, considered to be unacceptable and somewhat perverse to many economists. Marshall's approach, therefore, while convenient and elegant, is less than perfect.

John Hicks (1941) developed an alternative to Marshall's method. Hicks' framework does not rest on the use of cardinal utility but rather employs ordinal utility theory. Ordinal utility does not assign importance to the magnitude of utility but simply requires that a particular agent be capable of rationally ranking different consumption bundles according to his or her own preferences. That is, the concept of ordinal utility does not provide a measure of economic satisfaction. It merely allows us to describe preferences.

Hicks developed four measures of an individual agent's welfare change. They are:

- Equivalent Variation (EV)

  This is the change in income that would be required to provide the new utility level at the old prices, in response to a change in prices. In other words, it is the change in income that would be 'equivalent' to the proposed price change. Hovis (1984) specified EV as the minimum lump sum payment the individual would have to receive to induce him or her to voluntarily forego the opportunity to purchase at the new price set.

Figure 2.2 Equivalent Variation as a measure of welfare gain under a price decrease

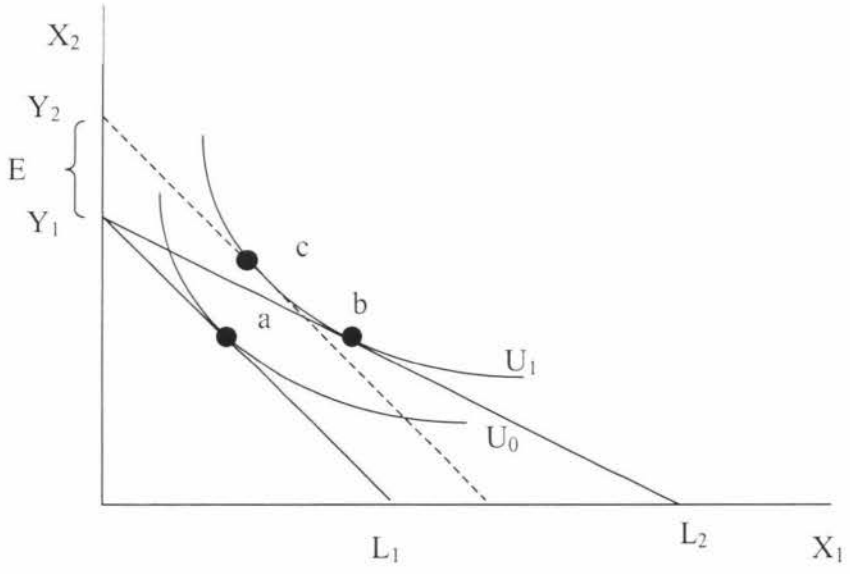


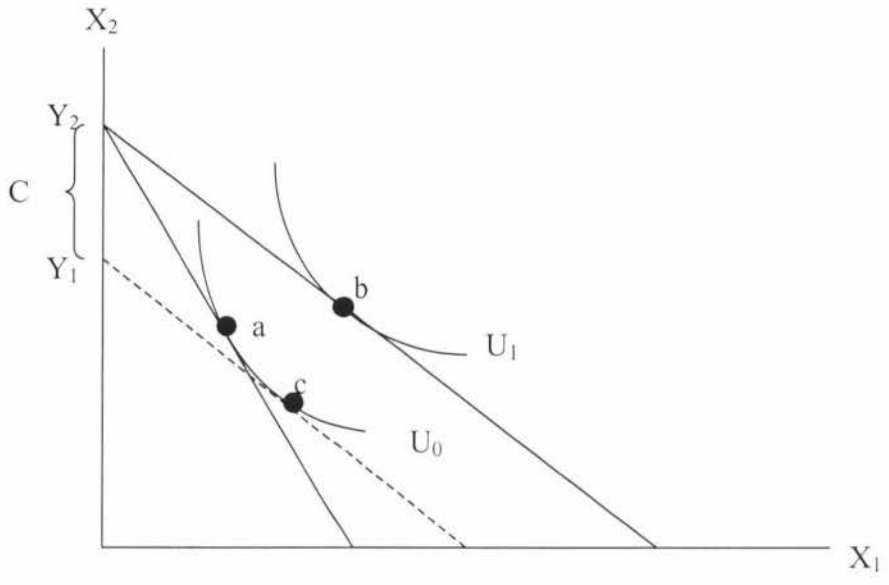
Figure 2.2 shows the initial point is at 'a'. When the price of X_1 decreases the consumer would have adjusted the position of maximum utility with the new price (L_2) at 'b', but the consumer is constrained to consume at the initial price set (L_1). Hence, the payment should be made as much as Y_2-Y_1 to allow the consumer to be as well off as at point 'b' on the higher indifference curve U_1 but force him or her to pay the original prices (point C).

- Compensating Variation (CV)

  This is the change in income that would be required to provide the old utility level at the new prices, in response to a change in the price. That is, the change in income that would 'compensate' the consumer for the effects of the price change.

Given the budget line L_1 and initial utility U_0, the consumer is maximising his utility at point 'a'.

Figure 2.3 Compensating Variation as a measure of welfare gain under a price decrease

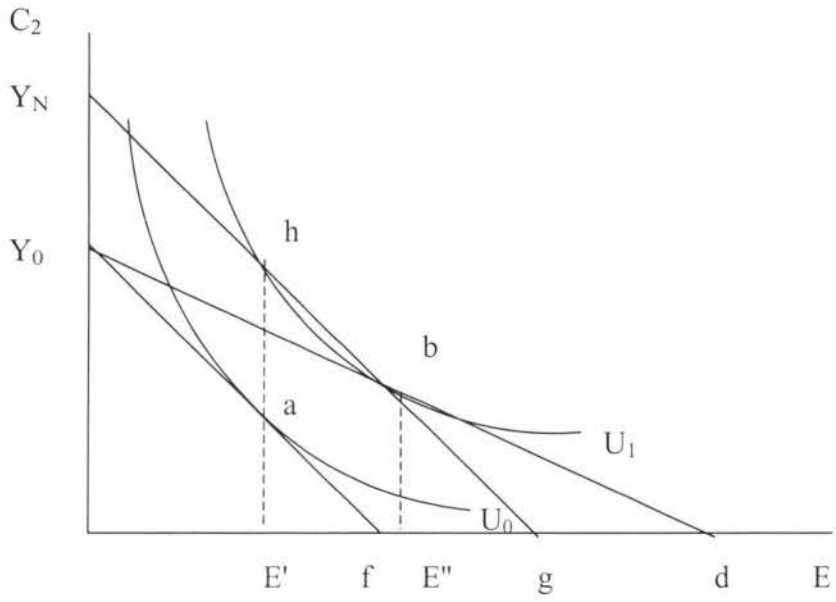


The figure above shows the decrease of commodity price which leads to the new budget line L_2 and brings about a new point of maximum utility at 'b'. The consumer would like to pay as much as Y_2-Y_1 to reach point 'b'. Hence CV is the maximum willingness to pay of a consumer to make himself or herself as well off as at point 'a', and point 'c' is the point of consumption under the new price.

- Equivalent Surplus (ES)

  This measures the amount that income would have to drop by to have the same effect as a decline in environmental quality. In other words this is the amount of money a person is willing to pay in order to avoid a reduction in environmental quality.

Figure 2.4 Equivalent Surplus



Equivalent surplus is the minimum amount of compensation paid or received that will leave the consumer in his or her subsequent welfare position in the absence of the price change if he or she is constrained to buy at the old price, the quantity he or she would have bought in the absence of compensation. Figure 2.4 shows an increase in environmental quality, represented by a shift from E' to E". This causes a shift from 'a' to 'b', with the implicit new ratio given by Y_0d. Y_Ng cuts the indifference curve for U_1 at 'h', giving us ES = ha = $Y_N - Y_0$. This is the amount of money that at the original prices, would, if paid to the individual, move him or her to the same utility level as the environmental improvement would have done, given that the improvement does not, in fact, take place (Perman, et al., 1999).

- Compensating Surplus (CS)

  This measures the amount that income would have to go up by to return utility to the original level as a result of a decrease in environmental quality. In other words this is the amount of money a person is willing to accept in compensation for a lower level of environmental quality.

  It is the maximum amount of compensation paid or received that will leave the consumer at his or her initial utility level following the change in price. If he

or she is constrained to buy at the new price, it is the quantity he would have bought at that price in the absence of compensation.

Figure 2.5 Compensating Surplus

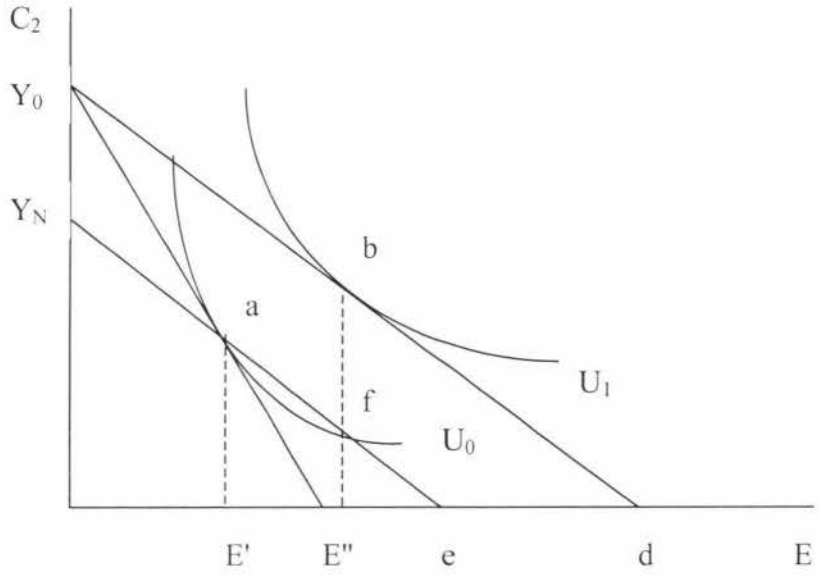
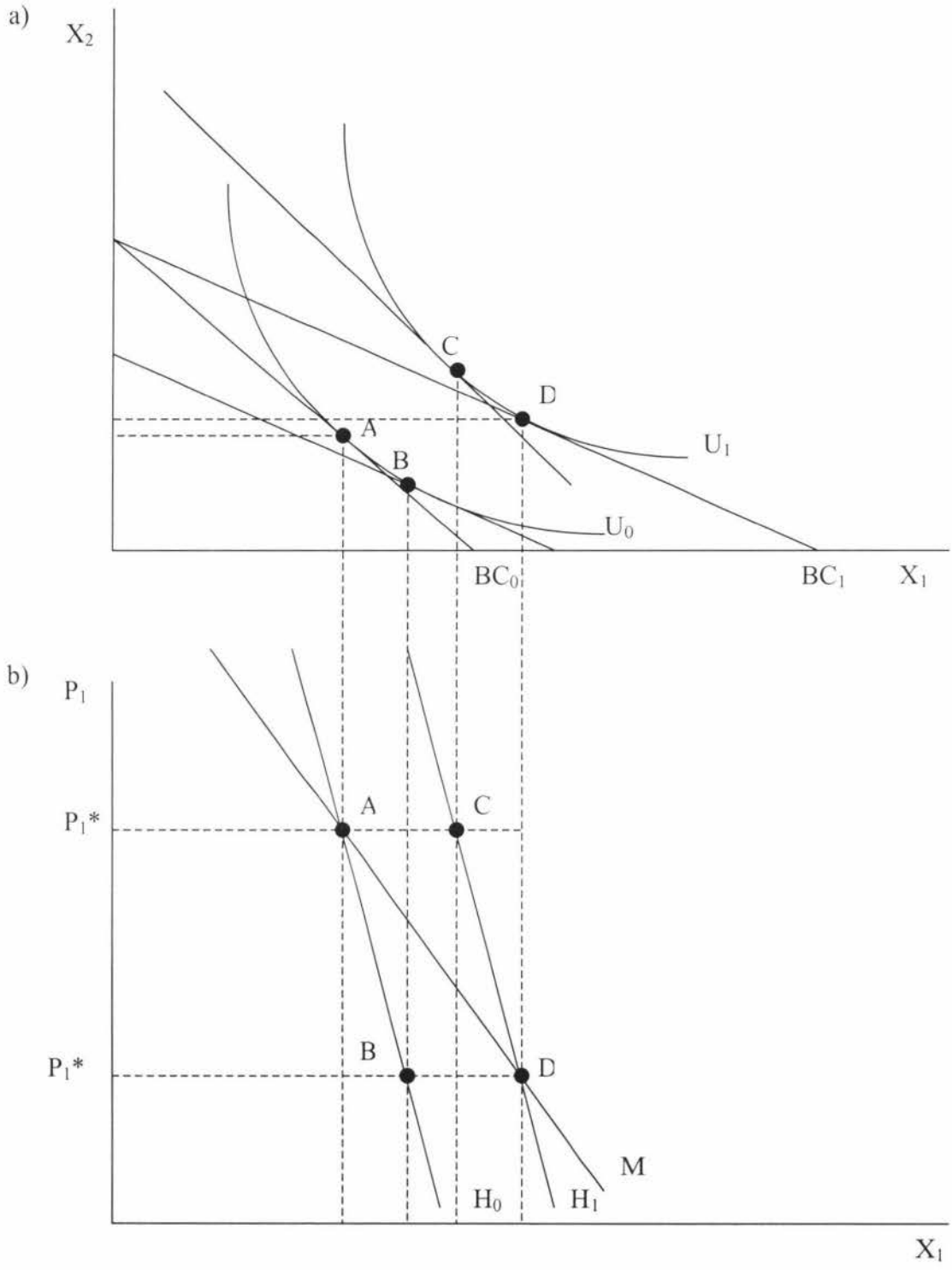


Figure 2.5 shows the slope of the budget line Y_0d, which gives us the price ratio implicit in the quantity increase, tangential to U_1, at 'b'. Y_Ne cuts the indifference curve for U_0 at 'f', where the level of E is E". CS is given by ha = Y_0-Y_N. This is the amount of money that, if foregone by the individual with the policy change, would result in him or her experiencing the pre-change level of utility (Perman, et al., 1999).

The Hicksian compensating and equivalent surplus restrict the quantity of the good purchased to be either the level of subsequent state (compensating) or the initial state (equivalent).

The basic difference between the Marshallian and the Hicksian formulations of consumer behaviour lies in the underlying assumptions. Marshallian demand asserts that an agent seeks to maximise utility subject to a constraint on income. Hicksian demand, on the other hand, asserts that the agent seeks to minimise expenditure subject to satisfying a particular reservation utility. These two principles yield very different demand curves. Consider the following example:

Figure 2.6 (a) Compensating variation of a price fall, (b) Hicksian and Marshallian demands



We can see in the figures how an agent's response differs under Marshallian and Hicksian formulations of demand. Again we have a consumer who consumes two goods x_1 and x_2 with prices p_1 and p_2 respectively. There is a decrease in p_1 shifting

the budget constraint from BC_0 to BC_1. The Marshallian demand change is reflected in the movement from point A to point D. Here, utility is maximised subject to income, which has increased in real terms. Points A and B show the Hicksian demand effects of this change-income is reduced so that utility is held constant at its original level (U_0) while subject to the new prices. Points C and D illustrate this same principle at the new (U_1) utility level.

The increase in Marshallian consumer surplus, due to the drop in p_1, is the area p_1*AD p_1**. The increase in Hicksian consumer surplus, due to the drop in p_1, is different depending on whether the measure is Compensating or Equivalent variation. In case of Compensating variation the area would be P_1*AB P_1**, whereas in the case of Equivalent variation it would be P_1*CD P_1**.

According to Perman (1999) page 384, in principle we are able to get a proper monetary measure of the utility effect of price changes for an individual if we can ascertain his or her willingness to pay or willingness to accept. If it is not possible to do that, but we know the individuals ordinary demand curves, we can measure the Marshallian consumer surplus. This we know is incorrect for increases or decreases in price, however we also know that it lies between the two correct measures.

In his well known article "Consumer's surplus without apology" (1976), Willig showed that for most cases of practical concern the error involoved in using Marshallian consumer surplus, with respect to either Compensating or Equivalent variation, will be less than 5 percent.

In evaluating the impacts of public policy, aggregate measures of consumer well-being are often used. This means that the effects on individual agents, in terms of welfare changes, are simply added to provided a measure of the total welfare impact on society. Societal well-being is seen as the total of all individual well-beings in that society.

This 'aggregate consumer surplus' is a means of measuring welfare implications but it also has difficulties. The main problem with employing this type of aggregation technique is that it pays no attention to the occurrence of the impacts.

Some, such as Randall (1987) argue that economic efficiency should be our sole decision criterion. This is a utilitarian philosophy; "any improvement in the total efficiency of a society must infer an improvement in the well-being of that society."

A Utilitarian Social Welfare Function (SWF) has the form:

$$W = W(U_1, U_2, U_3, \ldots\ldots U_n)$$

Where, W= Social Welfare

And U_i = Utility level of agent i

Specifically,

$$W = \sum_{i=1}^{n} U_i$$

However, it would be difficult to argue that the total welfare of society is simply an additive function of individual utilities. Other factors such as equality and distribution issues must surely come into play : "If an undesirable distribution of income exists or is created, maximisation of net social monetary benefits will not necessarily be a valid criterion of optimality" (Hufschmidt et al, 1993).

If we have no satisfactory Social Welfare Function, then rather than looking at the outcomes of a policy implementation and attempting to judge whether or not they are good or bad outcomes, we examine the decision making process instead. If the process of policy setting is fair, representative and democratic, then whatever emerges from that process must also be fair.

In modern practice, the concept of consumer surplus is used in the techniques of Benefit Cost Analysis (BCA) and Non-Market Valuation. According to Willig (1976) page 596, "at the level of the individual consumer, cost-benefit welfare analysis can be performed rigorously and unapologetically by means of consumer surplus". BCA is a procedure for comparing alternative courses of action by reference to the net social benefits that they produce. The principles underlying BCA and those underlying the notion of consumer surplus are tightly linked. Consumer Surplus is a measure of net benefits and costs for different members of society in varying degrees. For any given agent in a society the net effect may be either an increase or a decrease in that agent's consumer surplus. An increase in an agent's consumer surplus implies

an increase in society's overall well-being. A decrease in the consumer surplus of an agent implies a decrease in social welfare. What BCA attempts to do is identify all the costs and benefit of a particular action, policy or venture and their occurrence. Having done this these costs and benefits are aggregated to determine whether or not the project is worth undertaking. In effect, all of the individual consumer's surpluses are added up to obtain the total consumers' surplus and then we find out whether the project increases or decreases the total consumers' surplus. In conducting a BCA we are identifying the effects of a policy or project on the net utility of society i.e., its consumers' surplus.

2.3.2 Willingness to Pay and Willingness to Accept

The task of valuation is to determine how much better or worse off individuals are or would be as a result of change in or the provision of environmental quality. Economists define the value of a change in terms of how much of something else (usually expressed as an amount of money) an individual is Willing to Pay (WTP) to get this change or how much they would be Willing to Accept (WTA) in order to permit the change to occur.

Until recently, it was assumed that in most practical situations the difference between WTP or WTA measures would be small so long as there was an absence of strong income effects. Willig in 1976, developed a precise analytical expression of the size of this potential difference, and actually showed that in a wide variety of market situations, the divergence between WTP and WTA measures would be very small.

However, a substantial body of empirical evidence has been developed that provides convincing evidence that WTP and WTA measures are often quite different (Hammack and Brown, 1974; Gordon and Knetsch, 1979; Rowe, d'Arge, and Brookshire, 1980; Schulze, d'Arge, and Brookshire, 1981; Knetsch and Sinden, 1984). Yet, recommended best practice is to elicit WTP in contingent valuation surveys (Arrow et al, 1993).

Typically WTP measures turn out to be substantially less than WTA measures for the same policy change. The reaction of many economists to this evidence was to argue that the WTA results were unreliable and should not be treated seriously (Dwyer and

Bowes, 1979; Kahneman, 1986). The implication was that monetary estimates of well-being based on WTA measures should not be used in policy analysis.

There are several reasons why WTP is considered best practice. Almost all contingent valuation studies employ WTP with the values generated considered "reasonable" for whatever reason, although Arrow et al. (1993) consider such values to be on the high side. WTP makes people more cognisant of their budget constraints; WTP is bounded, while WTA could be unbounded. Yet, in many cases the appropriate measure is compensation demanded (Knetsch, 1993). In the determination of punitive damages in lawsuits, both sides have to come to accept WTP as the appropriate measure of non-use value. The wrongdoer accepts WTP because it results in lower values than WTA, while the plaintiff accepts WTP because it addresses the punishment aspect (Knetsch, 2000).

However, the difference between WTP and WTA measures has proven to be extremely robust in a wide variety of experiments, and appears to reflect a real difference in individuals' valuation of a policy change depending on how the policy is 'framed' or the individual's 'reference point' (Kahneman and Tversky, 1979; Tversky and Kahneman, 1981). Individuals weight (or value) losses from this reference point much more heavily than they do gains, i.e. the loss of $100 from current income will generally be perceived to be much worse than a gain of $100 is perceived to be a benefit. This is not simply because of the declining marginal utility of income. Instead, the utility function appears to be 'kinked' at the reference point.

This finding has three important implications. First, the gains from trade are likely to be overstated because people value highly what they must give up in the trade (Knetsch, 1990). More generally, most WTP estimates of the value of losses will be too low. Second, the decision on whether to use compensating or equivalent variation measures or WTP versus WTA would in many cases take on great practical importance because the losses associated with changes in the status quo or the reference point would weigh much more heavily than corresponding gains. Individuals tend to view compensation for a loss as two separate events: (1) a loss (which they greatly dislike), and (2) a money payment which is perceived as a gain from their new reference point (Knetsch, 1990). Policy measures that mitigate or

reduce losses may thus be more desirable than those that allow the damage to occur and then compensate the individuals affected. Third, there is no justification within economic theory for choosing between the WTP and WTA measures.

In summary, good economic analysis will require good judgement on the question of whether to use WTP or WTA measures of economic value (UNEP,1994).

2.4 Total Economic Value

The Total Economic Value (TEV) of the environment is made up of several values all of which affect one's satisfaction or utility. In relation to environmental resources TEV can be looked at from two perspectives: Use values and Non-use values.

Use Value

The value of the service flows that the public would derive from the resource (environment) in its natural state (Krutilla and Fisher, 1975), specifically by the actual use of the environment (Pearce and Turner, 1990). This is the value given to both the current and expected future use of a resource for commercial, sport, scenic and other activities (Kerr, 1986). It includes direct and indirect use values. Direct use occurs when the outputs of the resource are consumed directly whereas indirect use occurs when the functional benefits of the environment are consumed indirectly.

Option Value

Considering the risk associated with future demand or supply of the resource, people may anticipate to have an option of using the environment as a potential benefit as opposed to actual present value; and therefore payment may be made to retain the option of possible future use in addition to expected consumer surplus (Cicchetti and Freeman, 1971; Walsh et al., 1984; Pearce and Turner, 1990). Option Value is the value of a resource as a potential benefit. Some authorities refer to this value as the preservation value (Walsh, Loomis & Gillian, 1984). This value is revealed through the user's willingness to pay for the resource to be preserved with the hope of using the resource at some future time.

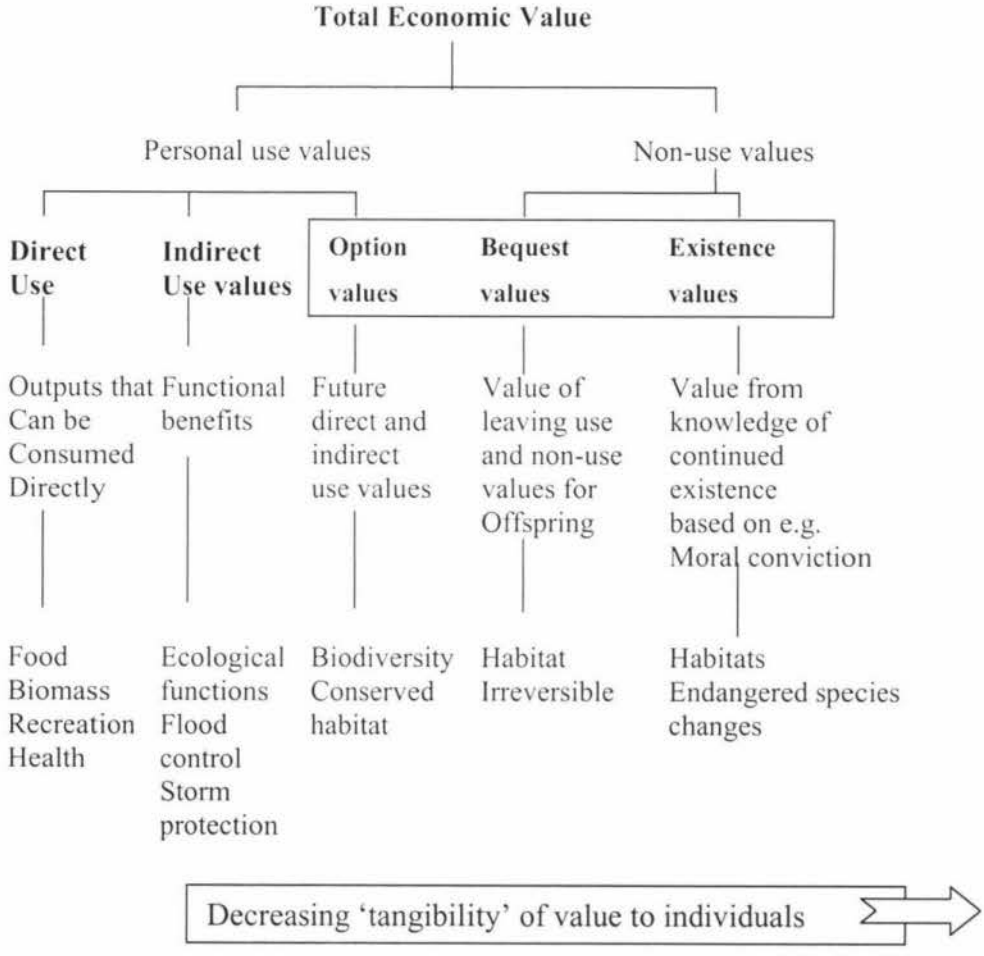
Quasi-Option Value

This value relates to willingness to pay to avoid an irreversible commitment to development now, given the expectation of future growth in knowledge relevant to the implications of development (Perman et al., 1999). Quasi-option value is based upon uncertainty regarding the future availability of information on use and value associated with resources facing possible irreversible development (Kerr & Sharp, 1987; Mitchell & Carson, 1993).

Existence Value

The willingness to pay for the knowledge that a resource exists even though no actual use is contemplated (Walsh et al., 1984). Existence value arises from knowledge that the service exists and will continue to exist, independently of any actual or prospective use by the individual (Perman et al., 1999) Existence value also includes bequest value which is the willingness to pay for the satisfaction derived from endowing future generations with a resource (Krutilla, 1967; Walsh et al., 1984; Kerr & Sharp, 1987).

Figure 2.7 Economic Values attributed to Environmental Assets



Source: ODI, OECD, 1995.

2.5 Benefit Valuation Methodologies

The measurement of welfare changes due to alternative use of resources for which competitive markets do not exist, commonly use non-market valuation techniques (Seller, Stoll & Chavas, 1985).

This section provides an overview of some of the different methodologies used, with varying degrees of success, to estimate the value of public goods, specifically those involving environmental quality. The nature of benefits from flood control schemes is such, that they can be evaluated properly only using the Contingent Valuation Method. Therefore we will concentrate on the CV method.

2.5.1 Market Related Valuation Approaches

These approaches indirectly measure the economic effect of a public good through its effect on the market system, e.g. productivity, cost of supply. In some instances market changes are readily observable and these approaches provide an inexpensive means of evaluation. However, with many public goods the problem is one of defining the relationship between environmental quality changes and a market good and assuming that the relationship fully reflects the value of the quality change. Examples of market related approaches are given below:

Property Value Method

A change in environmental quality will invariably be reflected in a change in value of nearby property. The magnitude of the gain or loss provides a measure of the cost or benefit from quality changes which are capitalised in the property values. The difficulty in applying this method is in establishing the correct relationship between quality changes and property value movement. Also the benefits accruing to land owners are likely to be only a portion of the total benefits of quality improvements (Mishan, 1978; Harris, 1983; Hufschmidt et al., 1983).

Wage Differential Approach

This method relies on the assumption that the supply of labour to a particular area is dependent on the living conditions and that the living conditions reflect environmental

quality. For instance a higher wage might be deemed necessary to induce a worker into a polluted area. This technique normally deals with risky jobs. The problem with this technique is in defining changes in quality between areas and isolating the quality factor from other wage influences (Meyer & Leone, 1977).

Market Substitute Approach

In some instances the public good to be valued may have a substitute which is a private market good i.e., easily valued. An example is where private swimming pools are a substitute for clean rivers. If the substitute effect can be established then quality changes as observed in the change in use of the private good can be valued. The difficulty with this method is in establishing the substitute relationship.

Alternative Cost Method

This procedure can be used in situations where the need to improve environmental quality can be satisfied by means other than actually making the improvement. In this case the value of the improvement is seen as the cost (opportunity cost) of making the alternative unnecessary e.g. providing a fish hatchery as an alternative to improving water quality.

2.5.2 Non-Market Valuation Approaches

Non-Market valuation approaches have been developed to overcome the absence of observable market values associated with public goods. There are basically two broad approaches to non-market valuation, each comprising a number of techniques. The approaches are the Indirect and Direct approaches.

2.5.2.1 Indirect Valuation Approaches

Indirect approaches are those techniques which seek to elicit preferences from actual, observed market based information. Preferences for the environmental good are revealed indirectly, when an individual purchases a marketed good with which the environmental good is related to some way. There are several techniques for valuing benefits of non-market goods, however there are two main approaches that are commonly used: the Surrogate market approach and the Conventional market approach.

a) The Surrogate Market Approach

This approach uses the price of substitutes or complementary goods to value an unpriced good. This method determines demand curves indirectly and therefore consumer surplus (Kerr,1986).

Surrogate market techniques involve looking at markets for private goods and services which are related to the environmental commodities of concern. The goods or services bought and sold in these surrogate markets will often have as complements (or attributes) and substitutes the environmental commodities in question. Individuals reveal their preferences for both the private marketed good and the environmental good when purchasing the private good. They leave what is called a "behavioural trail" as they make actual decisions that affect their lives (UNEP, 1994). These techniques are therefore sometimes preferred by policy makers because they rely on actual choices rather than the hypothetical choices involved in the direct approaches. Surrogate market approaches include Hedonic pricing and the Travel cost method.

Hedonic Pricing

The Hedonic pricing approach looks at markets for private goods for which the environmental good of concern is a weak complement (or attribute), in order to infer individuals' preferences for environmental quality. An example of this is the property market, in which one of the attributes of housing influencing an individual's decision to buy or sell, is the level of environmental quality, e.g. air pollution in the surrounding neighbourhood. Another example is in the labour market where the job attribute 'risk of death or injury', is traded against 'price' or the wage.

Travel Cost Method

This is one of the oldest approaches to environmental valuation, proposed in a letter from Harold Hotelling to the US Forest Service in the 1930's, first used by Wood and Trice in 1958, and popularised by Clawson and Knetsch (1966). This approach has been successfully applied for some years to recreation analysis. It can be used to value quality changes by measuring the associated change in recreational activity. The method examines the public's demand for a public good by modelling expenditure with respect to travel. The method involves using travel costs as a proxy for the price of visiting outdoor recreational sites. A statistical relationship between observed visits

and the cost of visiting is derived and used as a surrogate demand curve from which consumer's surplus per visit-day can be measured. The method has been widely used for valuing the non-market benefits of outdoor recreation, especially recreation associated with national parks and public forests (Bowes & Krutilla, 1989). Recent developments of the technique allow the welfare effects of changing the characteristics of a site to be analysed.

b) The Conventional Market Approach

Conventional market approaches are used in situations where the output of a good or service is measurable. These approaches observe physical changes in environmental quality and estimates what differences these changes will make to the value of goods and services which are marketed. Where the damage shows up in changes in the quantity or price of marketed inputs or outputs, the value of the change can be measured by changes in the total 'consumers plus producers surplus' (UNEP, 1994).

Unlike other techniques, these techniques are not concerned with what people say they prefer, or with inferring environmental values indirectly by observing what people do. It is particularly useful, therefore, where individuals are unaware of the impact on utility of a change in environmental quality. In such cases, a direct WTP estimate would clearly be an inappropriate measure (Bann,1998).

Some of the techniques that may be distinguished are: the dose-response technique, the replacement cost approach, the production function approach, the human capital approach, and the damage function approach.

(a) The Dose-Response Technique

Dose-response estimates measure the physical impacts of an environmental change. For example, they may measure the physical impact of deforestation on soil erosion or water pollution on health. When individuals are unaware of the impact on utility of a change in environmental quality then the direct elicitation WTP or WTA is an inappropriate measure and so dose-response procedures which do not rely on individuals preferences can be used.

The aim of this technique is to establish a relationship between environmental damage (the response, e.g. soil erosion) and some cause of the damage (the dose, e.g. deforestation) such that a given level of damage can be associated with a given change in environmental quality. The technique is feasible only where there is a known relationship between the dose and response (Bann, 1998). The next step is to relate the environmental damage to a change in value (quantity or quality) of a good or service which is marketed. The approach is mainly applicable to environmental changes that have impacts on marketable goods and so it is unsuitable for valuing non-use benefits (UNEP, 1994).

(b) The Replacement Cost Technique

This technique looks at the cost of replacing or restoring a damaged asset to its original state and uses this cost as a measure of the benefit of restoration. The approach is widely used because it is easy to find estimates of such costs.

This approach is applicable if there is an environmental standard that must be met. It is possible to argue that the remedial work must take place because of some constraint such as a water quality standard. Under such a situation the costs of achieving that standard are a proxy for the benefits of reaching the standard, since society can be assumed as having sanctioned the cost by setting the standard (UNEP, 1994).

c) The Production Function Approach

The production function approach is essentially the dose-response approach in its most basic form. It looks at changes in environmental resources which lead to marginal changes in the output of a marketed good and values the impact directly in terms of output changes at market prices (Pearce and Moran 1994).

This approach relates output to different levels of inputs of the factors of production (land, labour, capital, raw materials). The concept is that a change in the use of one of these inputs, such as labour, will result in a certain change in output. Production is therefore a function of these inputs and can be related to them algebraically. Environmental resources may similarly be thought of as 'inputs' to be included in the production process where they can be measured and where they have a clear effect on output (e.g., soil fertility and air and water quality) (Bann, 1998). Following these

principles, the production function approach relates environmental inputs to output, and measures variations in output as a result of the changes in the various kinds of input.

More formally, the production function for a single output may be given by:

$$Y = F(X, Z)$$

where X is a set of inputs (e.g., land, capital) and Z is the input of the unpriced environmental resource. Assume that output "Y" which has a market price can be measured. If prices of inputs X are not expected to change when supply of the environmental resource (Z) changes, then the economic value of the change in the supply of Z is the value of the production change associated with the change in Z at constant inputs of the other factors (X) (Pearce and Moran 1994).

d) The Human Capital Approach

This approach estimates the cost of bad health as a result of environmental change. Evidence on the relationship between a change in the environment and health effects may be found in epidemiological data, controlled group experiments, or other observations. The economic cost of bad health is estimated through its effect on the productivity of workers. The term human capital is used because the approach is based on the value of a person as a working unit (the person's subjective valuation of health, his or her WTP for better health, the cost of pain and suffering, etc., are not considered) (OECD 1995; Bann, 1998).

e) The Damage Function Approach

Damage functions use dose-response data to estimate the economic cost of environmental change. The physical impact, for example soil erosion caused by an environmental change such as deforestation, is converted to economic values by associating that impact with a given change in a marketed output (e.g., crop yields) which can be measured using the market or shadow prices for the units of output (Bann, 1998).

2.5.2.2 Direct Valuation Methods

In the direct valuation approach an attempt is made to elicit preferences by either experiments or survey based techniques.

a) Experimental Approach

This approach simulates a market by placing respondents in a position in which they can express their hypothetical valuations of real improvements in specific environments. For example, if an analyst wanted to know how much people would be willing to pay to live in a city with improved water quality, an experiment could be conducted in which water quality standards and property taxes would be raised in some cities and not in others. The analyst could then see how many people found it worthwhile to move to cities with improved water quality and higher taxes (UNEP, 1994).

b) Survey-Based Techniques

Survey-based valuation techniques seek to directly elicit consumer willingness to pay or willingness to accept compensation for various changes of environmental goods and services. They are consumer-orientated rather than market orientated. These techniques aim to measure changes in utility, in monetary terms, of a resource by simulating a hypothetical situation to test consumer preferences (Forbes, 1984). This valuation technique is based on a hypothetical situation rather than actual consumer behaviour, as has been exercised in surrogate market approaches (Hufschmidt et al, 1983; Braden & Kolstad, 1991; Mitchell & Carson, 1993).

Harris (1983) has classified survey methods into the following major areas in which some success has been obtained. They are listed below:

Trade off games

This type of survey method involves the determination of individual preferences from among various outcomes. The technique systematically varies the money value level until the individual is indifferent between particular combinations of money and the environmental good. The value of interest from this method is the trade-off in money that one makes for the increase in the quantity of the environmental good. An estimate of aggregate willingness to pay for the increased quantity can be obtained by interviewing an adequately sized, representative population sample (Sinden & Worrel, 1979; Kirkland, 1988).

Costless choice

In this method, preferences between various quantities of goods are determined through direct questioning. The choice is costless because the comparison is between alternatives which are desirable and free. In order to maintain the above analogies, one of the alternatives can be an unpriced, environmental good, while the other can be a physical good. By keeping the quantity of the environmental good constant and varying the other, a type of bidding game is effected. The individual will not have to pay anything to receive the good, nor will they lose any existing environmental good if the physical good is chosen. This method also minimises some of the biases found in bidding games which combine a desirable with an undesirable outcome (Rohn, 1969).

Delphi Technique

This technique involves putting together a group of experts and independently asking them to place values on one or several goods. The outcomes are presented to the group, outlying values are explained and rationalised by the appropriate expert and then the group members independently re-evaluate and make new value judgements. Through successive rounds the hope is to minimise the variance of the outcome. The essence of the method is its neutrality using only indirect communication to avoid personality and group confrontation to influence the decision process. The accuracy of the method depends greatly on the quality of the panel, its ability to reflect society's values and the facilitation of the process (Dalkey and Helmer, 1963).

2.6 Contingent Valuation Method (CVM)

The Contingent Valuation Method uses survey questions to elicit people's preferences for public goods by finding out what they would be willing to pay for specified improvements in them. The method is thus aimed at eliciting their willingness to pay in dollar amounts (Mitchell & Carsons, 1993). It is called 'contingent valuation' because the valuation is contingent on a hypothetical scenario put to respondents. Its main use is to provide input to analyses of changes in the level of provision of public goods or bads, and especially of environmental 'commodities' which have the characteristics of non-excludability and non-divisibility (Perman et al, 1999).

Contingent valuation studies have been implemented to date for a long list of environmental factors: air quality, the value of view related amenities, the recreational quality of beaches, preservation of wildlife species, congestion in wilderness areas, hunting and fishing experiences, toxic waste disposal, preservation of wild rivers among others. In fact, CV methods have spread into non-environmental areas; for example, the value of programmes for reducing the risk of heart attacks, the value of supermarket price information, and the value of a seniors' companion programme. Over time the method has been developed and refined to give what many regard as reasonably reliable measures of the benefits of a variety of public goods, especially environmental quality.

CVM is most appropriate under conditions where environmental changes have no direct impact on marketed output, it is not feasible to observe people's preferences directly, the population in the sample is representative, interested in, and well informed of the subject in question, and there are adequate funds, human resources and time to do the study properly (obtaining reliable information requires a substantial investment of time, care and resources, which makes a good CVM exercise expensive).

The steps in a CV analysis are the following:

1. Identification and description of the environmental quality characteristic to be evaluated.
2. Identification of respondents to be approached, including sampling procedures used to select respondents.
3. Design and application of a survey questionnaire through personal, phone, or mail interviews (in recent years, focus groups have sometimes been used).
4. Analysis of results and aggregation of individual responses to estimate values for the group affected by the environmental change.

(Field,1997)

Characteristics of CVM

1. CVM differs from conventional market research in that it is concerned with a hypothetical event, namely an improvement or deterioration in the environment.

2. CVM often deals with changes in public goods - such as air quality, landscape, or the existence values of wildlife. However, it may also apply to environmental goods that are sold to individuals, such as improved water supply and sewage.
3. CVM may apply to both use values (water quality, viewing wild animals, direct enjoyment of a view), or non-use values (existence values)
4. The values that people express in CVM interviews depend (are contingent) upon such factors as the description of the good, the way it is provided, and the way it would be paid for.

(OECD, 1995)

2.6.1 Historical Perspective

The development of contingent valuation rose out of a need to evaluate benefits and costs associated with public goods. The first identified description of contingent valuation was in 1947 in an article by S. V. Ciriacy-Wantrup about measuring the benefits of preventing soil erosion. Its first apparent use was by Robert Davis in his 1963 Ph.D. dissertation, measuring the value of a recreation area to hunters and wilderness advocates. Since then, many studies have been conducted on a wide range of commodities, including environmental amenities and natural resources.

Ridker and Henning (1967) incorporated WTP in their pollution surveys. Their methodology, though, was largely a property value approach. Hammack and Brown (1974) surveyed western waterfowl hunters seeking to find what they were willing to pay to forgo their hunting rights. Cicchetti and Smith (1973) sought to value the benefits wilderness hikers derived from hiking by asking them their WTP or WTA compensation to reduce congestion in the area.

Randall et al. (1974) used the CVM to study benefits of air visibility. This study became pivotal to many later studies that designed WTP questions in hypothetical or contingent market frameworks. The CVM has been widely employed in studies of water quality. Greenley et al. (1981) investigated the economic benefits associated with water quality improvement with particular interest in public perceptions of option and preservation value. Brookshire et al. (1982) used CV to measure the benefits of improving air quality. Desvouges, Smith and McGivney (1983) used CV to estimate the value of water quality improvements for water-based recreational purposes. Harris (1983) tested the suitability of the CVM to water pollution in New

Zealand. Boyle and Bishop (1987) used CV methods to investigate the benefits of undertaking steps to preserve the American bald eagle. Fried et al. (1999) used the contingent valuation method to estimate the willingness to pay and assess the benefits of wildfire risk reduction for residents in Michigan, USA. Williamson (1999) carried out a contingent valuation study to determine the economic value of the recreational fishery in New Zealand. Krupnick et al. (2000) undertook a contingent valuation survey estimating the willingness to pay for mortality risk reduction. A Contingent Valuation study was undertaken by Stumborg et al. (2000) on Lake Mendota to estimate the aggregate willingness to pay for water quality improvement and the reduction non-point source pollution.

A number of researchers have used the approach to estimate willingness to pay to avoid ill health. For example, Chestnut et al. (1988) asked respondents how much they would be willing to pay to reduce half the number of bad asthma days experienced each year.

2.6.2 Approaches to CVM

There are several approaches within the broad grouping of CVM. Some of them are briefly discussed below:

Bidding Games

This approach entails asking people for their willingness to pay for an improved bundle of goods (compensating variation) or willingness to accept compensation for an inferior bundle of goods (equivalent variation) (Hufschmidt et al., 1983).

As a bidding game, this approach entails suggesting higher and higher amounts to the respondents until their maximum WTP is reached (Hanley et al., 1997). The questionnaire or interviewer suggests the first bid (the starting point bid or price) and the respondent agrees or denies that he or she would be willing to pay it. An iterative procedure follows: the starting point price is increased to see if the respondent would be willing to pay it, and so on until the respondent declares that they are not willing to pay the extra increment in the bid. The last accepted bid, then, is the maximum willingness to pay (Bann, 1998).

This approach does however suffer from several drawbacks. The main drawback is that of starting point bias. This may influence respondents to value the good higher than it should be.

Open-Ended Questions

As an open-ended question, individuals are asked for their maximum WTP with no value being suggested to them, or no aid of a bidding price being given. By not using a starting bid and influencing respondents answers, this method allows a mail survey to be undertaken (Bishop & Heberlein, 1987; Rosawati, 1993).

Respondents have often found it relatively difficult to answer such questions, especially where they have no prior experience of trading with the commodity in question (Hanley et al., 1997). As no indication is given of the expected range of answers, the single bid tends to result in much higher standard deviations around the mean (Hufschmidt et al., 1983). The reason for this is that most people have not valued such a resource before and may never have considered what its economic worth might be (Bishop & Heberlein, 1987).

Payment Card Method

With the payment card approach, a range of values is presented on a card which may also indicate the typical expenditure by respondents in a given income group on other publicly provided services. This helps respondents to calibrate their replies. This method was developed by Mitchell and Carson (1993) to avoid starting point bias in the bidding games approach.

The question asked of respondents is: "What amount on this card, or any amount in between, is the most that you would be willing to pay for the level of good being proposed ?" (Mitchell & Carson, 1993; Rosawati, 1993).

A study conducted by Boyle and Bishop (1987) found that a bidding game and payment card produce statistically indistinguishable value estimates for the same environmental asset, and both values were biased upwards.

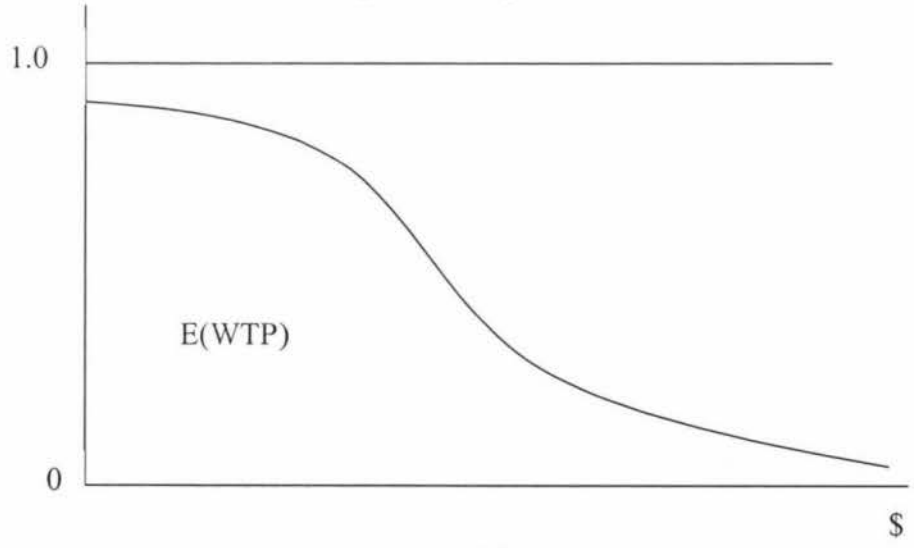
Dichotomous Choice

In the Dichotomous Choice approach, a single payment is suggested, to which respondents either agree or disagree. This approach asks respondents to answer 'yes' or 'no' for the specific willingness to pay question for the good being proposed, with no further iteration. Such an approach is often known as the Closed-ended Referendum approach.

The sample is split into different groups (split sample), each respondent being asked whether he or she would be willing to pay a single sum. This sum is different for each group. The sums concerned should obviously be chosen with care, so that potential freeriders are discouraged from giving misleading, negative answers. The upper and lower bound values should be pre-tested so that, for WTP questions, the upper level would produce almost 100% rejection, while the lower one would elicit almost 100% acceptance. The different WTP values are then distributed randomly across the split sample (Bann, 1998).

The prices are randomly assigned to respondents so that it is possible to predict the probability for any person, of given characteristics, being willing to pay the amount (Kerr, 1986; Mitchell & Carson, 1993). This approach seems free from the influence of strategic behaviour since the respondent will agree if their willingness to pay is greater than or equal to the price asked, or disagree otherwise (Mitchell & Carson, 1993). Analysis is based on plotting the probability of being willing to pay against the dollar amount nominated.

Figure 2.8 Expected WTP



A development of this method is known as 'trichotomous choice' valuation. Here, respondents who are indifferent to the offer price are explicitly modelled, along with those who reply 'yes' or 'no'. This state of indifference may be produced by vagueness on the part of respondents about the environmental change in question. Finally, double bounded referendum models present those respondents who say 'no' to the first amount with a lower amount and those respondents who say 'yes' to the first amount with a higher amount (Hanley et al., 1997).

A study by Bateman et al. (1992) used a large sample open-ended format WTP question in order to estimate the distribution and range of WTP bids. A bid function was then estimated so that a probability of discrete bid acceptance curve could be mapped out. Eight WTP bid levels were subsequently chosen for a dichotomous choice experiment. The results were compared with the open-ended experiment and it was found that a dichotomous choice respondent was more likely to assent to the question 'are you willing to pay $X?' than an open-ended respondent is likely to state a WTP of $X or above. It was thought that several factors may have influenced this result including open-ended format studies are subject to free rider problems whereas dichotomous choice are not; dichotomous choice formats may be subject to interviewer bias and are more likely to exhibit anchoring bias thereby biasing the mean WTP upwards.

To conclude, open-ended approaches are likely to provide a lower bound WTP estimate below which true WTP is unlikely to lie, while dichotomous choice approaches provide an upper bound WTP estimate above which true WTP is unlikely to lie.

2.6.3 Weaknesses of CVM

Its greatest weakness is that it relies on people's views, rather than evidence of their market behaviour. Many possible biases may arise in responses, but some of these can be controlled - if not eliminated - by survey design. CVM relies on the respondents' understanding of the environmental issues at stake, and the likely impacts on them. This assumes a certain level of education and environmental awareness on the part of the respondents (OECD, 1995).

Given the contingent nature of CVM, a poorly designed and implemented survey may easily influence and distort individual answers. This leads to survey responses that bear little resemblance to the relevant population's true WTP. These difficulties, or potential bias sources are listed below. Bias is an element in the study that consistently skews results in one direction, thereby leading survey results away from the population's true WTP.

Information bias

A respondent's WTP may be affected by the amount and quality of information available on which to base their valuation. Hypothetical market scenarios provide less information than an actual situation, which in turn can lead to biased responses. To counter this, respondents must be well informed about the good they are valuing and the situation they are in. Studies in the past have utilised visual aids to ensure a consistent interpretation (Randall, 1974; Harris, 1983). Sometimes it is beneficial to offer more time to answer, for instance by returning the following day to complete the interview.

How much information to provide is a judicious decision; providing too much data may itself be a source of bias. Ideally this should be tested by comparing the answers of the sample with a control group being offered less information. At the very least, all respondents within a sample should be offered the same information, and interviewers should be sparing in the amount of supplementary information they volunteer in response to questions (Bann, 1998).

Empirical evidence suggests only a weak information bias; some studies finding a threshold effect for information build up, below which no bias is detectable but above which a positive and weak effect is found. Other studies have found no significant information bias, although bid variance was found to fall as information increased (Pearce & Morgan, 1994; Bann, 1998).

Starting point bias

The suggestion of an initial starting point in a bidding game can significantly influence the final bid, e.g. choosing a low (high) starting point leads to a low (high)

mean WTP. The use of starting points can reduce the amount of non-responses and the variance in open-ended type questionnaires, though it may also result in respondents not giving their answer serious thought and taking a cognitive short cut in arriving at their decision. One solution to this problem is the use of a "payment card" whereby the respondent selects a bid from a range shown on the card (Cummings et al., 1986; Kirkland, 1988). However this can result in an 'anchoring' of bids within the range of bids asked. Optimal bids should be set so that the lowest bid results in all respondents accepting it, and the highest bid results in all respondents rejecting it. Within this range, bid levels should reflect the distribution of bids so that, optimally, each bid interval reflects the same proportion of the population.

Hypothetical bias

Hypothetical bias measures the influence of an artificial market against an actual market on the valuations. The hypothetical nature of the market in CV studies can render respondents' answers meaningless if their declared intentions cannot be taken as accurate guides of their actual behaviour. Some writers have looked at hypothetical bias in terms of increased bid variance and low model reliability. Others view the use of hypothetical markets as having other distinct problems. Research into hypothetical markets and their predictive ability has looked at attitude-behaviour relationships and experiments which examine substitution of real for hypothetical markets (Bann,1998).

The Fishbein-Azjen attitude behaviour model (1975) looked at the links between stated attitudes and actual behaviour. In order to minimise hypothetical bias, this model argues that the specified attitude (WTP scenario) must closely correspond to the specified behaviour (the precise good behaviour). It argues also that predictive power will be greater the fewer the influencing relationships between a component in the model and behaviour. Finally, it notes that where a respondent is dealing with familiar behavioural situations, attitude will be a better predictor of behaviour.

Thayer (1981) used a site substitution measurement technique in conjunction with a bidding game when valuing welfare loss to check for differences between the hypothetical and actual results. He found the difference due to hypothetical bias to be insignificant. Correct design will alleviate most of the problem.

A survey of experimental tests reveals that by using a WTP format instead of a WTA format, hypothetical bias, which may be a significant problem in WTA studies, can be reduced to an insignificant level. The tests usually compare the hypothetical bids with bids obtained in simulated markets where real money transactions take place. Results from such studies suggest that the divergence between actual and hypothetical WTP is much less than that for WTA, the reason being that respondents are more familiar with payment rather than compensation scenarios (Hanley, 1990).

Strategic bias

Strategic bias arises when respondents deliberately understate their true preference (WTP) for a good, or exaggerate the amount of compensation they would really need. Strategic bias depends on the respondent's perceived payment obligation and his or her expectation about the provision of a good. Where individuals actually have to pay the reported WTP values, then there is the temptation to understate their true preferences in the hope of a 'free ride' (i.e., the opportunity of benefiting from the provision of a public good without contributing to it, or the chance of paying less for an environmental change than it is really worth to them). Alternatively, if the price to be charged for the good is not tied to an individual's WTP response, but the provision of the good is, then over-reporting of WTP may occur in order to ensure provision. Another motive would be to use the survey to register a protest at the idea of a charge for something they would expect to enjoy free (a protest response).

Empirical investigations of strategic bias are well documented. One approach of testing for strategic bias argued that if true WTP bids are theoretically normally distributed then strategic behaviour would bias this distribution towards zero (Brookshire et al, 1976).

Minimisation of occurrence of strategic behaviour can be achieved by framing the CVM questions in an incentive compatible way such that this type of behaviour is not induced. One particular approach is to ask respondents to make bids for a good under three scenarios - only the highest bidder gets the good; everyone gets the good if WTP is above a certain level; everyone with a positive WTP gets the good. The first scenario is assumed to give true WTP, the second has a weak free rider incentive and the third a strong one.

Empirical evidence suggests that the latter two scenarios do indeed produce WTP values below their true level. Such findings tend to come from open ended format questions rather than discrete response approaches, where free riding behaviour is likely to be minimised. Some authors suggest implementation of a property rights approach, in which respondents receive provision of a good relative to their given WTP. This removes the tendency to free ride. This is not applicable to most environmental public goods for which non-use and altruistic values act as a disincentive to free ride.

Besides trying to reduce the likelihood of strategic bias, economists have been keen to test for its presence. Two approaches are possible. First, one can examine the distribution of received bids and compare this with the hypothesised distribution of true bids (Brookshire et al., 1976). Strategic behaviour is assumed to flatten the distribution as relatively more high and low bids are made (over- and understatements). Negative bids are excluded, so that negative valuations accumulate as zeros. This tends to skew the distribution. Brookshire et al. assume that the true distribution is normal, concluding from this that there is no strategic bias in their sample, but the true distribution might equally be bimodal. However, even if one observed a concentration of very high and very low bids, this could be caused by other factors such as undetected protest bidding. Very high values may in any case cancel out very low values (Hanley et al., 1997).

The second approach is to include questions to test for bias in the survey. This was done by Rowe et al. (1980): respondents were offered the chance to revise their bids following information on the mean bid recorded in the sample. Thus an individual who did not believe that their bid would actually be collected, but who wanted the environmental improvement to go ahead, might drastically increase their stated WTP in order to raise the mean bid, if they also thought that the actual decision over whether or not the environmental improvement would be provided would be based on this sample mean.

One common way of counteracting strategic bias is to ask respondents a 'yes' or 'no' question about whether they would be willing to pay a particular sum (dichotomous

choice). Other precautions against strategic bias can also be taken. Respondents should not be told that payment by others would be compulsory, but should be told that the provision of services would depend on the demonstration of adequate WTP. They could be told that if they exaggerate the amount they would be WTP, they may not be able to afford it if that amount were really charged. Conversely, if WTP were understated, then the service might not be provided. The latter also bring an undesired outcome. Another suggestion may be to get respondents first to understate and then overstate their true bid (using appropriate incentives) and then using the resultant interval of bids as guidance for policy makers. This however implies the acceptance of strategic behaviour within CVM (Hanley et al., 1997).

Mitchell and Carson (1993) argue that strategic behaviour is more likely in mail surveys than in telephone or interview surveys, as respondents have more time for 'strategising' in the first case. They conclude that, on balance, strategic bias is of minor importance in well-designed CVM studies, especially as informational requirements for strategic behaviour are high. Recent findings from game theory and from experimental economics indicate that truth-telling may be optimal in revealing preferences over public goods in many circumstances (Evans and Harris, 1982; Hanley et al., 1997).

Overall strategic bias problems have not been found to be a significant problem in practice.

Interview and respondent bias

The way interviewers conduct themselves can influence responses. Another variant of the problem is compliance bias, which arises when a respondent tries to guess the correct answer or tries to answer without giving the problem proper consideration. To minimise this problem, interviewers should be well trained, and they should follow the wording of the questionnaire exactly, with the respondents being offered a choice of prepared responses.

Payment vehicle bias

WTP replies may be biased by the choice of payment vehicle specified in the question; for example, cash price, entry charge, indirect tax, property tax supplement,

voluntary donation, once and for all current charges. This is referred to as instrument bias. On the other hand, the 'bias' between various forms of payment may reflect people's genuine preferences. Thus, they should not be disregarded or corrected for. To minimise this bias, controversial payment vehicles should be avoided and the payment method should be as realistic as possible (Bann, 1998).

Part or Whole bias (Embedding)

One common error is for the respondent to confuse the subject of the enquiry with other, wider, questions that arise in his or her mind. There is evidence to suggest that people have problems understanding certain kinds of questions that depend on insights into their own feelings or their memory of events or feelings. This is often so with environmental issues which evoke deeply held moral, philosophical and religious beliefs. Respondents may interpret a hypothetical offer of a specific good or service to indicate an offer for a broader set of similar goods and services. This is also referred to as the embedding problem since the value of the good being sought is embedded in the value of the more encompassing set of goods or services reported by the respondent. If, for example, people were asked their WTP for the preservation of a particular natural habitat, their answer may betray their values for the whole of that natural habitat in the country (or even in the world, in the case of threatened species).

The only safeguard against this bias is for the background information to be clear that the questions relate solely to the case in point. This problem is indicative of an even broader problem with obtaining accurate answers. For a single individual the total amount he or she is willing to pay for improved environmental goods and services may be determined by the composition or components of the total set of environmental projects and policies to be funded. However, this information is unlikely to be obtained from the aggregation of values based on a set of CV studies designed to measure individuals' preferences for narrowly defined environmental goods.

Design bias

Design bias derives from the information presented to the respondent, the sequence of presentation, the bidding instrument and the starting point of such bidding.

2.7 Summary

Looking at the various non market valuation techniques, the use of conventional and surrogate market approaches seem to be inappropriate for this study, since many of the benefits accruing from flood protection cannot be traded in the market and they do not have substitute goods or services.

Since the provision of a flood protection scheme is a public service, it is therefore important to take into consideration the preferences of the people concerned on the issue. The Contingent Valuation survey approach is preferred to other techniques as it allows for the involvement of the public in the decision making process. The decision-makers, in essence make decisions on the behalf of the public and the use of this approach will ensure accountability and transparency on their part.

The use of CVM gives results that are comparable to those obtained from other non-market valuation techniques. It also requires less data collection compared to other techniques. There are also certain values and situations that are suitable for evaluation by the CVM but not by any other technique. Based on these reasons it is considered most suitable to use the CVM for the valuation of indirect benefits from flood protection.

Due to inherent biases such as starting point bias, and the fact that the bidding game elicitation method requires that personal interviews be undertaken, the use of the bidding games in this CVM study is considered inappropriate. The direct elicitation method of WTP is preferred to the other methods, as it allows for more the implementation of more survey methods and it does not suffer from inherent starting point bias.

The open-ended format of the WTP question is not considered to be the most appropriate format for this CV study because the individuals would find it very difficult to place a value on something that not normally traded in the market. The Dichotomous choice format is therefore a better option because it simplifies the valuation process for the respondents by asking them to either agree or disagree to paying a specified amount of money towards indirect flood protection.

Personal interviews, although accurate are normally very expensive and time consuming. The self administered mail survey approach is however cheaper and less time consuming. As the financial resources and time is limited for this research, the mail survey method is chosen to be the most appropriate approach.

For the purpose of this research the Contingent Valuation method has been chosen as the most appropriate technique to use for the quantification of indirect benefits from flood protection. In particular, the Dichotomous choice format of the Contingent Valuation Method will be used in the form of a mail survey.

Chapter 3
The Lower Waikato Area

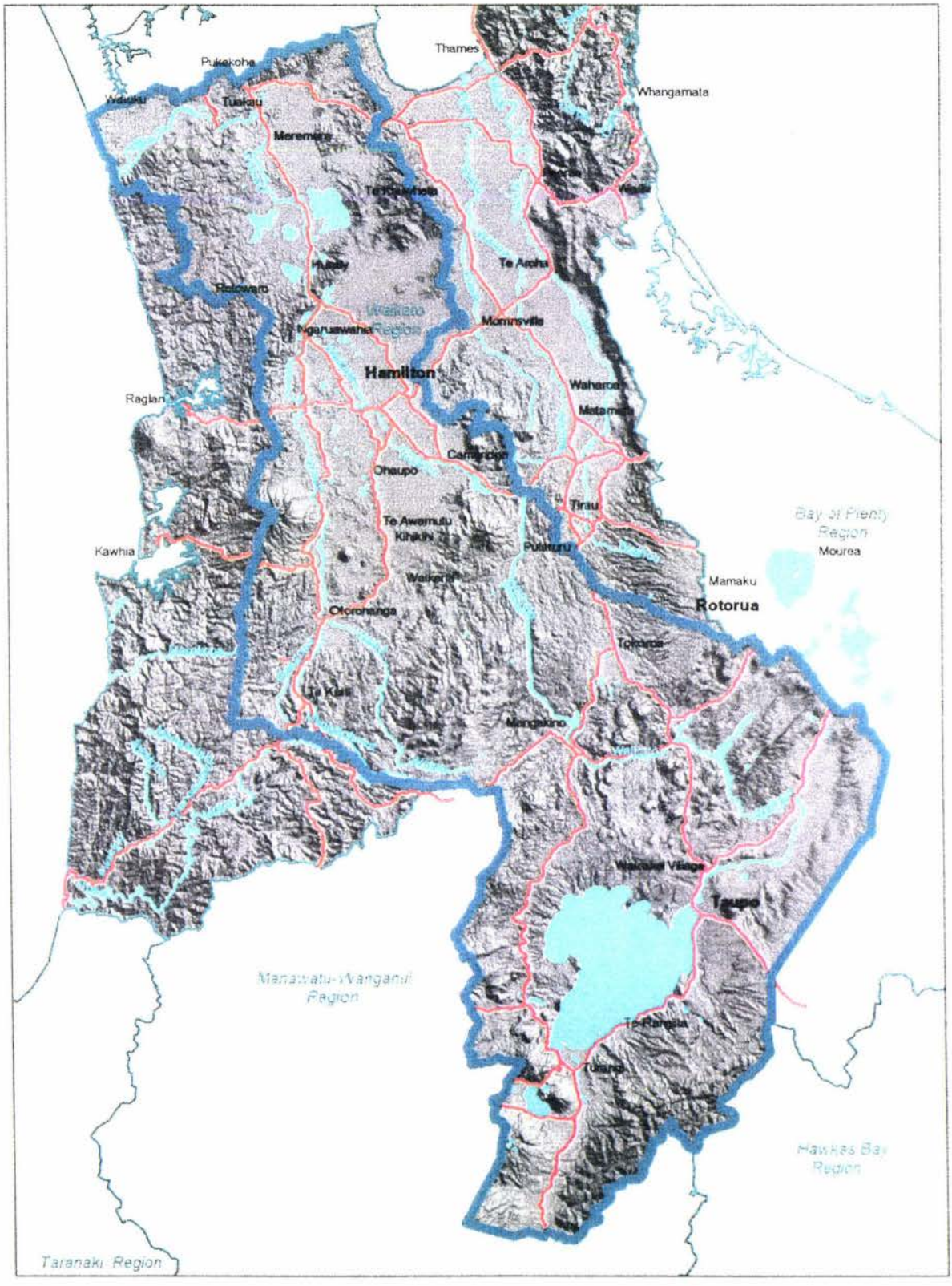
3.0 Introduction

The Waikato River, the longest in New Zealand, is located in the central North Island. Rising on the slopes of Mount Ruapehu in Tongariro National Park as the Tongariro River, it flows north through Lake Taupo and, issuing from the lake's north-eastern corner, tumbles over Huka Falls and flows north-west to enter the Tasman Sea south of Auckland at Port Waikato. The river is 264 miles (425 km) long. It has a gentle gradient and carries a heavy load of ash from the volcanic highlands. Looking at the map of the Waikato catchment we can see that numerous lakes and lagoons have been formed along the lower reaches of the Waikato River.

The Waikato River has a total catchment area of some 14,250 km^2. The single largest tributary of the Waikato River is the Waipa River, originating in the Rangitoto Ranges in the southern King Country. The Waipa River has a catchment of some 3050 km^2 and flows in a generally northerly direction through the township of Otorohanga and the settlements of Pirongia and Whatawhata to join the Waikato River at Ngaruawahia (Environment Waikato, 1997).

3.1 The Lower Waikato Catchment

The Lower Waikato River is the part of the Waikato River that extends from Ngaruawahia to the Waikato Heads. Before it reaches Ngaruawahia the river is generally confined within a well-incised channel. At Ngaruawahia the flood plain is low and wide, and the river becomes wider and slower flowing. Lakes and wetlands dominated the Lower Waikato flood plain in its natural state, however today much of this land has been drained and brought in to agricultural production. The river widens out and branches in to many smaller channels threading their way through countless small islands below Taukau before entering Maioro Bay. The river exits from Maioro Bay into the Tasman Sea via a single narrow channel at the Waikato Heads.



Waikato Catchment

State Highway

Major Rivers

Waikato Catchment

Not To Scale

Environment Waikato
REGIONAL COUNCIL

7-Nov-2001

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The Lower Waikato area has a flood plain of approximately 36,400 hectares dominated by lakes and wetlands. A considerable area had been developed for agricultural production, but production in the past has been severely affected by regular flooding.

The flood plain consists mainly of alluvial or peat based flats. With very little fall through the river system, the slow flowing Waikato river remains high for a considerable period and leaves behind extensive long term flooding or ponding which takes weeks to evacuate.

The Mangawara River catchment is included within the LWWCS. Most of the Mangawara part of the scheme is not affected by flooding of the Waikato Waipa Rivers, but by flooding from its own catchment, with relatively explosive run-off from the hill country. Relatively swiftly flowing streams cause flooding over a considerable area of alluvial, peat, and clay based flats, with in most cases, flood waters quickly receding, in contrast to the much longer lived flooding in the Lower Waikato.

3.1.1 The Lower Waikato and Wetlands

The lowland plains of the Waikato northwards from Te Awamutu to the Waikato River mouth and the Hauraki Plains support a large and diverse number of wetlands, including the two largest remaining wetlands (excluding lakes) in the North Island. The Waikato wetlands form an internationally important wetland complex, with many different wetland types, each with a diverse and often unique biota.

In its widest sense the term wetlands includes "permanently or temporarily wet areas, shallow water and land-water margins. They are characterised in their natural state by plants and animals that are adapted to living in wet conditions" (Stephenson et al, 1983). The Resource Management Act (1991) definition of a wetland is similar and includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that adapted to wet conditions.

At around 20,000 years before present, the Waikato River cut into the Karapiro Valley and on emergence from the narrow gorge near what is now Cambridge, deposited vast fans of alluvium through the Lower Waikato plains. The river was very mobile and created a series of channels and depressions across the plains, damming existing streams and rivers which led to the formation of many lakes. Larger depressions were lined with impermeable pumice silts and became waterlogged swamps (NIWA, 1997).

3.1.2 Influence of Maori

Evidence of human activity in the Lower Waikato dates back to at least 700 years ago, with widespread deforestation of lowland areas. Much of the area not occupied by lakes, swamps and bogs was covered with manuka scrub, or fernland vegetation (Cranwell, 1939). Modification of wetlands would have been restricted to localised activities like damming or drainage. The wetlands offered a substantial resource to pre-European Maori as a source of food, habitation and flax fibre, and also pa sites and as caches for various artefacts (Barr, 1996).

3.2 The Lower Waikato Waipa Control Scheme (LWWCS)

The Lower Waikato Waipa Control Scheme is a comprehensive river control scheme designed to provide flood protection and drainage improvements within the flood plains of the Lower Waikato and Waipa Rivers. The protected areas can be seen in the map of the LWWCS.

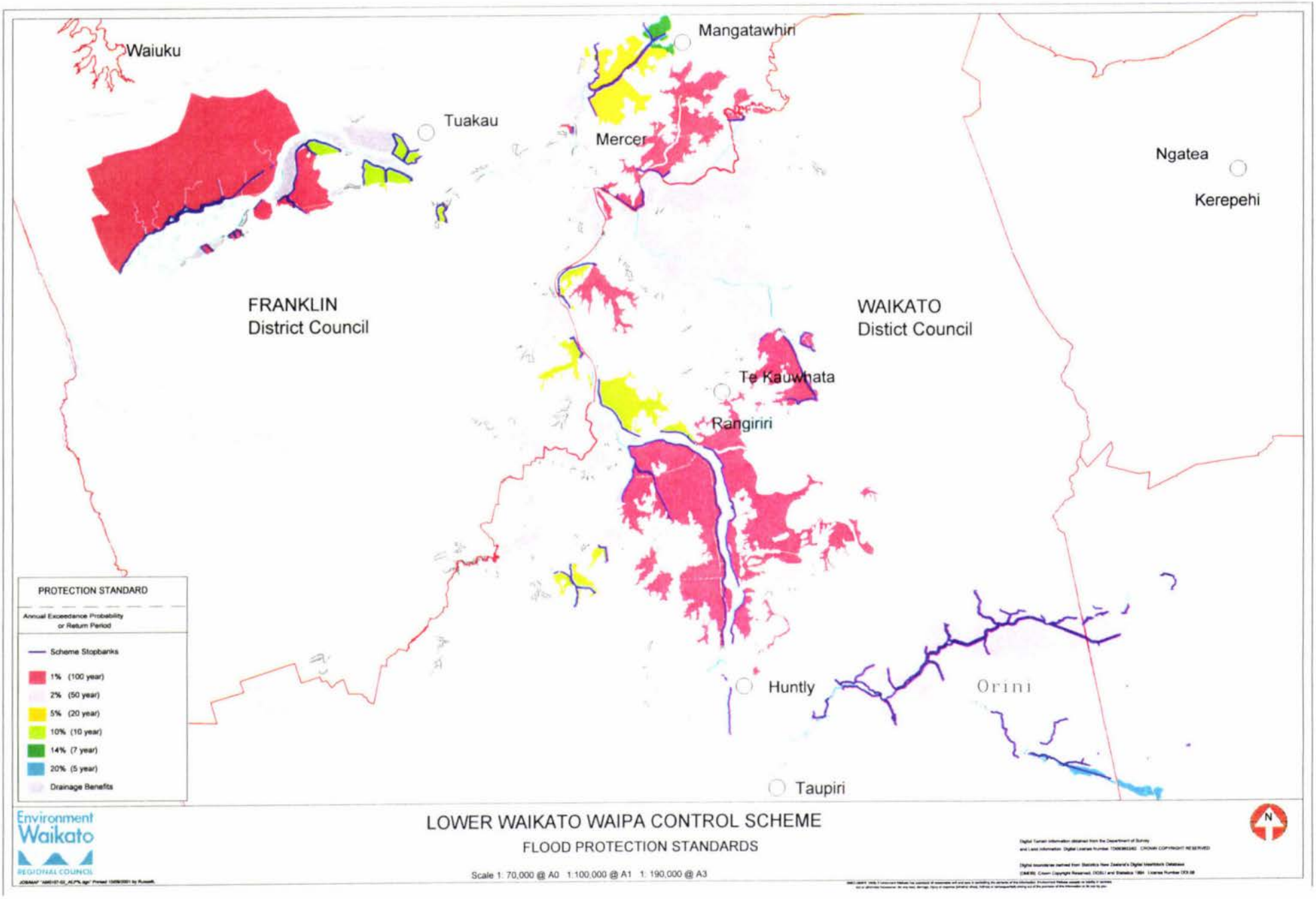
Approximately 17,200 hectares of the original area of low-lying land in the Lower Waikato is directly protected by the LWWCS. An additional 16,500 hectares receives benefit from improvements to the waterways and river channels and the Community Works designed to control ponding areas. The LWWCS also provides protection to approximately 8,300 hectares of rural land within the Mangawara River Valley. In addition to protecting pastoral land, the Scheme provides protection to the urban settlements of Te Kuiti, Otorohanga and Huntly.

The main objective of the Lower Waikato Waipa Control Scheme is to provide flood protection to rural agricultural land in the Waipa and Lower Waikato Valleys and to

provide individual protection for the towns of Te Kuiti, Otorohanga and Huntly (Environment Waikato, 1997).

Protection is achieved by a combination of the following:

- Stopbanks providing direct protection to specific areas, including floodgates and pump stations for evacuating water from behind stop banked areas (shown in the map of the LWWCS).
- Willow clearing along river channels where infestation severely restricted flood capacity
- Improvements to the channel of the Waikato River including river training and dredging
- Control of the natural ponding and storage within Lake Waikare, and the Whangamarino Swamp.


Waiuku
Tuakau
Mangatawhiri
Mercer
Ngatea
Kerepehi
FRANKLIN
District Council
WAIKATO
Distict Council
Te Kauwhata
Rangiriri
Huntly
Orini
Taupiri
PROTECTION STANDARD
Annual Exceedance Probability or Return Period
Scheme Stopbanks
1% (100 year)
2% (50 year)
5% (20 year)
10% (10 year)
14% (7 year)
20% (5 year)
Drainage Benefits
Environment Waikato
REGIONAL COUNCIL
LOWER WAIKATO WAIPA CONTROL SCHEME
FLOOD PROTECTION STANDARDS
Scale 1: 70,000 @ A0 1:100,000 @ A1 1: 190,000 @ A3
N

3.2.1 Historical Background

The arrival of the first Europeans in the Waikato initiated attempts to modify and control the Lower Waikato River. The Waikato Maori used the river as a major transport route, and the colonial government's military forces also used it during the invasion of the Waikato in the 1860's. Initial attempts to control the river were largely directed at improving its navigability. The first comprehensive survey of the river below Rangiriri was conducted in 1913.

In the past, the Lower Waikato River floodplain was poorly drained, low lying, floodable land, wetlands and lakes. Much of this land was developed for agricultural purposes with the arrival of the European. The Aka Aka Drainage Board held its inaugural meeting in November 1895, and was, as far as can be ascertained, the first such board in New Zealand. The first authority charged with controlling the river for both navigation and flood control purposes was set up as early as 1911. The Waikato River Board met with limited success in its activities and the effects of river training works carried out by the Board was the subject of a commission of inquiry held in 1917. A further commission, the Auckland Canals and Inland Waterways Commission, established in 1921, recommended the abolition of the Waikato River Board, its works being severely condemned. Until the late 1950's there was no single body responsible for management or control of the Lower Waikato River though the Public Works Department carried out a number of surveys and investigations related to flood control and drainage (Environment Waikato, 1997).

During the 1950's the low natural level of protection against flooding of large areas in the Lower Waikato was clearly emphasised by floods in 1953, 1956 and 1958. The greatest of these floods was that of 1958. In addition to inundating rural agricultural land for long periods, this flood caused severe damage within the boroughs of Te Kuiti, Otorohanga and Huntly (Waikato Valley Authority, 1983).

The former Waikato Valley Authority was created in 1956 in an atmosphere of urgency, with the specific objective of controlling flooding in the Lower Waikato and Waipa Catchments. The wealth of hydrological data collected during the 1958 flood allowed the WVA to produce a comprehensive proposal for a flood control scheme for the Lower Waikato and Waipa Catchments. These proposals were set out in a

report to the Authority in October 1959. They included a detailed strategy for stopbanking, channel improvements and control of natural storage to protect flood prone land in the lower Waikato. In addition, the proposal called for individual protection for the townships of Te Kuiti, Otorohanga and Huntly, and outlined proposals for channel improvements to the Waipa River (Environment Waikato, 1997).

After obtaining approval from the government, the LWWCS started in 1961. The Scheme was commenced under a deed of agreement signed by the Waikato Valley Authority, the constituent Counties and Drainage Boards, and the Crown, in the early 1960's. A major review of the scope and financing arrangements of the LWWCS was undertaken in 1976 and 1977, and final decisions were made on those works to be included in the Scheme and those to be removed. At this time new deeds were signed which superseded the previous deed. All the agreed works were substantially complete by 1982. The total replacement cost of the Scheme in today's values is approximately $135 million (Environment Waikato, 1997).

Once the Scheme was completed in 1983, the Waikato Valley Authority undertook a major review which validated the hydrological and hydraulic performance of the Scheme and confirmed the economic justification for the works.

The reorganisation of local government in 1989 resulted in the Waikato Catchment Board (the successor to the Waikato Valley Authority) being amalgamated with the Hauraki Catchment Board, all drainage boards in the Waikato Region, and numerous other small local bodies to form the Waikato Regional Council. The overall responsibility of the Lower Waikato Waipa Control Scheme was then transferred to the Waikato Regional Council.

In the late 1980's and early 1990's concerns regarding the level of maintenance of the Scheme and its ability to perform to design standards began to emerge. In 1990 the Waikato Regional Council conducted an audit of the structural condition of the Scheme works. This audit confirmed that deficiencies existed (Environment Waikato, 1997).

3.3 Research Area

In this study we attempt to estimate the benefits from flood protection received by the indirect beneficiaries of the LWWCS. For this purpose the indirect beneficiaries of the scheme had to be identified first. With the help of the land classifiers in the region and Environment Waikato's Geographical Information System the indirect benefit areas were identified.

3.3.1. The Indirect Benefit Areas

According to Boyes Campbell & Associates (2001), land in these areas are considered to derive an indirect benefit from the LWWCS due to proximity to the protected flood plain. In general terms, the area comprises of flat to undulating and hilly land, unlikely to be surrounded by flood water in the absence of the scheme works, but nevertheless with reliance to a greater or lesser degree on the range of indirect benefits. We can see from the map of the indirect benefit areas that the area is a more or less contiguous one, extending from the catchments of the Mangawara in the east, and Lakes Waahi and Whangape in the west, to the Waikato River mouth, encompassing all of the local catchments of the flood plain.

There is a considerable range in the degree of the indirect benefit obtained in the various locations within the indirect benefit area. For this purpose the indirect benefit area has been split up into three different classes:

3.3.1.1 Indirect benefit area A

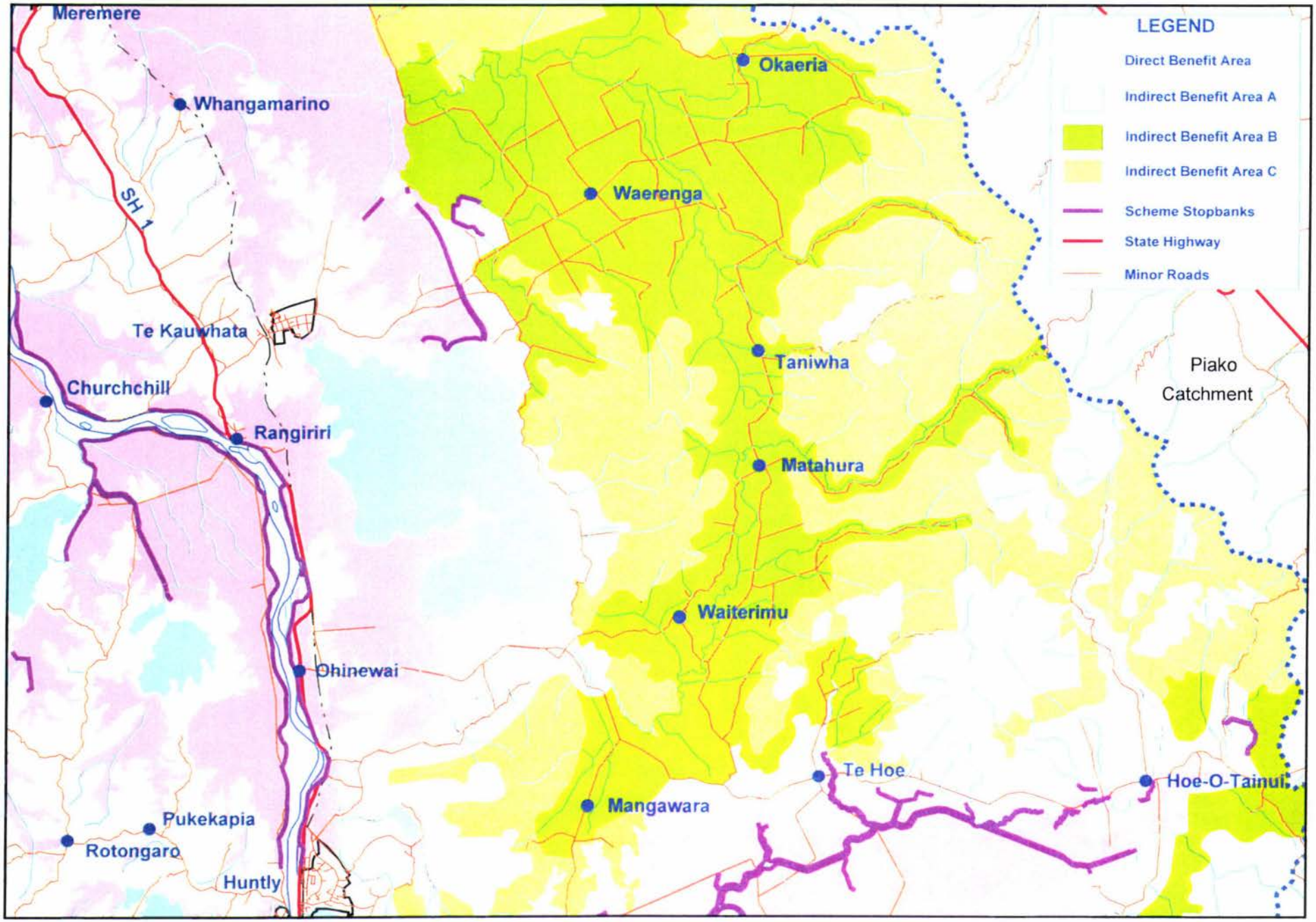
This land is within close proximity to the protected flood plains, and ranges generally from flat to undulating to very easy hilly in contour. It is land that is used, or has the potential to be used, in conjunction with land of the protected flood plain. It has the greatest reliance on the infrastructural, economic, and community factors as set out herein, and land use is likely to be dairying or cropping. Productivity is generally high, apart from some small areas immediately contiguous to the protected flood plain, where productivity may be moderate.

3.3.1.2 Indirect benefit area B

This is land, which is situated in close proximity although generally within 10 kilometres of the immediate flood plain area. It is lesser quality land, generally hilly in contour and likely to be used for sheep and cattle farming. It retains a moderate reliance on infrastructural protection on and through the flood plain, but with a rather lesser benefit from community protection. It is likely to be used for dairy and cropping purposes, it is of high productivity potential and will have some economic linkage to the land on the flood plain with an interest in sustaining a viable local economy.

3.3.1.3 Indirect benefit area C

This is land relatively remote from the protected flood plain. It is generally lesser quality; steep hilly land utilised for sheep and beef farming. There is limited economic linkage to the flood plain, and community protection is of lesser importance. There is however, a reliance on the protection of the infrastructural assets, particularly the main transport routes and core services, to a greater than that which pertains in the wider catchment beyond Ngaruawahia. The land lies generally at the eastern and western extremities of the project catchment, but mainly within 20 kilometres of the flood plain. Severe flooding of pre-scheme magnitude in the area between Huntly and Tuakau could be expected to have effect on the economic and social lives of property owners.


Meremere
Whangamarino
SH 1
Te Kauwhata
Churchchill
Rangiriri
Ohinewai
Pukekapia
Rotongaro
Huntly
Okaeria
Waerenga
Taniwha
Matahura
Waiterimu
Mangawara
Te Hoe
Hoe-O-Tainui
Piako
Catchment
LEGEND
Direct Benefit Area
Indirect Benefit Area A
Indirect Benefit Area B
Indirect Benefit Area C
Scheme Stopbanks
State Highway
Minor Roads

3.4 Summary

In this chapter some information on the Lower Waikato area in general has been provided. A description of the LWWCS and it history has been outlined. The indirect benefit areas of the scheme which are of main interest for this study have also been identified and described. In the next chapter, the process of undertaking the Contingent Valuation survey for this study is explained.

Chapter 4
Methodology

4.0 Introduction

The method chosen for this research is Contingent Valuation, as discussed in Chapter 2. The Contingent Valuation Method is undertaken through the form of a survey. It relies on people's valuation of changes in their circumstances given a hypothetically constructed scenario. This chapter discusses the benefits to be valued, the development of the survey, the relevant population and the survey's implementation.

The purpose of the survey is to help estimate the value of indirect benefits that residents gain from the current flood protection provided by the LWWCS.

4.1 Identification of Benefits

The benefits from flood protection schemes are significant and wide-ranging. These benefits can be broken down into two basic types: direct and indirect benefits.

4.1.1 Direct Benefit

Direct benefits accrue to the people living in the floodplain area that would flood if the scheme were not in place. The LWWCS provides direct benefits to private land and property by providing flood protection from the main rivers and tributary streams. The direct benefit area covers both urban and rural properties. Without the protection from the LWWCS, property in the direct benefit area would be totally or partially flooded.

The Rating Powers Act of 1988 provides the Council with a specific mechanism for rating flood protection and drainage schemes. In particular Section 41, which states:

41 (2) Where the rate is in respect of works for the protection of land from flood or erosion or for the conservation of soil or the management of water, a Board shall for the purposes of subsection (1) of this section, give consideration to:

(a) In relation to direct benefit,-

(i) accruing from the works concerned and the responsibility, the likelihood, frequency, depth, and severity of flooding and erosion; and

(ii) The likelihood, frequency, and extent of damage to land and the improvements to land; and

(iii) The improvement of drainage; and

(iv) The need for water management generally,-

In relation to the actual and potential uses of land and by reference to the advantages for their care and maintenance.

4.1.2 Indirect Benefit

These kinds of benefits accrue to third parties (those not directly protected by the scheme) and can often accrue collectively and widely throughout the region. In the event of a flood, the property falling in the indirect benefit areas would not be flooded but access, communication lines and peace of mind could be affected in the absence of the LWWCS.

The proposed benefit categorisation of the Lower Waikato Waipa Control Scheme splits up the Indirect benefit into Local Community benefits and Regional Community benefits.

Local Community Benefit

People within the catchment boundaries, which historically have not been affected by floods but live in close proximity to the protected floodplain area, receive indirect benefits from the flood protection scheme. This type of indirect benefit is called the local community benefit.

Indirect benefits resulting from the Scheme to the local community within the vicinity of the Scheme include:

- Communication assets including roads, electricity, water and telecommunications are protected, giving them confidence to create the need for the amenities and services that follow.
- As a result of direct benefits, indirect benefits also accrue to all those who use and rely on the Lower Waikato region for the many services and amenities it provides.

- Confidence within local community to reside, work and invest in turn generating further economic activity.

In the Lower Waikato Region classifiers have interpreted the Local Community indirect benefits to also include other parameters such as:

- Provision of an adequate flood warning system
- Maintenance of an institutional capability for dealing with flood events
- The general increase in values which arises from increased production and productivity, and
- Increased peace of mind.

Regional Community Benefit

The people living further away from the floodplain who benefit from increased economic activity in the protected floodplain area receive a Regional benefit.

The Regional benefit is intended to recognise the relatively low level of indirect benefit received by the greater Waikato region as a whole and it reflects the benefits to the region from protection provided by the LWWCS.

The emphasis of this research is on the identification and estimation of the Local Community indirect benefit.

In relation to indirect benefits, Section 41 of the Rating Powers Act states:

41 (2) Where the rate is in respect of works for the protection of land from flood or erosion or for the conservation of soil or the management of water, a Board shall for the purposes of subsection (1) of this section, give consideration to:

(b) In relation to indirect benefit,

(i) The establishment or preservation of economic units of land; and

(ii) The protection or establishment of water, sewage, drainage, electrical, gas, and other services and of works, services, and amenities to which rates from the land may be applied; and,

(iii) The protection or establishment of communications and of any other property, service, or amenity within or benefiting the land.

The estimation of indirect benefits is acknowledged to be extremely difficult and subjective. For example, Judge E B Anderson in his decision in the 1982 appeals heard against the Waihou Valley Scheme classification in respect to indirect benefit, that: "No rigid formula was provided by the classifiers nor, in my view can any such rigid formula be adopted" (Environment Waikato, 1999).

Based on discussions and consultations with people living in the area, land classifiers and Environment Waikato staff, the following were identified as important and relatively significant indirect benefits accruing to people in the Lower Waikato:

- Protection of roads and access
- Protection of lines of communication
- Provision of a flood warning system
- Protection of recreational and conservation areas, and
- Peace of mind.

These are the main benefits that the Contingent Valuation conducted in this study sets out to quantify.

4.2 Contingent Valuation Design

In 1992, the United States National Oceanic and Atmospheric Administration Agency (NOAA) undertook a high level review regarding the validity of the CV method. The panel concluded that CV could be useful, however certain practices would seem to be vital for the generation of reliable willingness to pay estimates. The panel's report on their findings was published in January 1993 (Federal Register, 1993). NOAA Recommendations have had a significant influence on what is considered "best practice" in undertaking a CV study, their findings have been developed into a set of proposed guidelines for future legally admissible CVM studies.

The principal recommendations were as follows:

1. A dichotomous choice format should be used.
2. A minimum response rate from the target sample of 70 percent should be achieved.
3. Personal interviews should be employed, with some role for telephone interviews in the data gathering stages.
4. Willingness to pay measures should be sought, rather than willingness to accept compensation.
5. After excluding protest bids, a test should be made of whether willingness to pay is sensitive to the change in the environment.
6. CVM results should be calibrated against experimental findings, otherwise a 50 per cent discount should be applied to CVM results.
7. Respondents should be reminded of their budget constraints.

(Federal Register, 1994)

These measures are, at the very least, a rather strange mixture of theoretically based recommendation and crude rules of thumb. According to Hanley et al. (1997), "it would be unfortunate if all CVM practitioners felt constrained to stick to these guidelines in future research", since the guidelines can be quite hard to follow. Therefore in this research we try as much as possible to stick to these guidelines, but do not constrain ourselves by them.

4.2.1 Survey Population

An important step in developing a Contingent Valuation survey is to identify the population that is likely to be affected by the proposal (Mitchell & Carson, 1993). Since the majority of the indirect benefits of the flood control scheme rest with the local community, this makes them the relevant population. In New Zealand the people who potentially benefit from the scheme are also required to pay for it.

The indirect beneficiaries of the LWWCS as identified by the land classifiers and the availability of a computerised Geographic Information System (GIS) enabled the development of a classification where the direct and indirect benefit areas could be expressed separately. Furthermore, the indirect benefit areas were broken down into three different classes (A, B and C), based on among other things, the distance from

the scheme area and elevation of land. With the help of the GIS and the Waikato Regional Council's databases, the people and ratepayers living in the indirect benefit areas were identified and their addresses were obtained.

The amount people are willing to pay for the benefits from flood protection reflects their valuation of the benefits they receive. This is because the perceived value of a good stems from the benefits it yields. The Contingent Valuation method works by getting people to think about these benefits before they determine the value of the good to them. However, historically flood control schemes have been at least partially financed through rates. The person who pays the rates for a premise, may not occupy that premise. The ratepayer in such a case would not be the principal beneficiary of the services of the system, rather the tenants or occupiers would. Since the occupiers would experience the benefits, it is them and not the absent ratepayer that need to be surveyed.

4.2.2 Sampling Procedure

The total number of addresses provided by the Regional council was approximately 1500. Assuming a response rate of 40 percent, it was decided that for this survey the goal was to collect about 300 observations. Recent surveys that have employed the CVM have achieved response rates between 35 and 50 percent (Coursey, 1998; Stumborg et al, 2000). This is therefore a reasonable good figure in regard to finances available to carry out the research. It therefore required that a total of at least 300/0.40 = 750 potential respondents be contacted.

4.2.3 Survey Objectives

The objectives of the survey provide the primary direction to determine what format of CVM is best. The objectives are:

1. To obtain an accurate indication of the willingness to pay for flood protection to indirect beneficiaries.
2. To gather information to determine the most significant factors influencing the amount an average household is willing to pay.
3. To gather people's opinions and attitudes towards paying for flood control in the Lower Waikato.

4.2.4 Survey Method

Contingent Valuation surveys are conducted using personal interviews and mail questionnaires. The form or method that is chosen to conduct the survey will depend on the survey population, the objectives of the survey and the constraints to undertaking the survey.

Many researchers believe that the best way to survey people is by means of a personal interview, which involves an interviewer soliciting information from a respondent by asking prepared questions. A personal interview has the advantage of having a higher expected response rate than other methods of data collection. In addition, there will probably be fewer incorrect responses resulting from respondents misunderstanding some questions, because the interviewer can clarify misunderstandings when asked to. The interviewer must however be careful not to say too much for fear of biasing the response. It can be difficult for an interviewer to always appear neutral when conducting an interview (Kolstad, 2000). To avoid introducing such biases as well as to reap the potential benefits of a personal interview, the interviewer must be well trained in proper interviewing techniques and well informed on the purpose of the study. The main disadvantage of personal interviews is that they are expensive and time consuming, especially when travel is involved. The NOAA Panel has however recommended personal interviews be conducted whenever possible. The advantage personal interviews have over mail questionnaires is that the interviewer can tailor the question to a respondent's circumstances (Mitchell & Carson, 1993).

A telephone interview is usually less expensive, but it is also less personal and has a lower expected response rate.

A third way to administer surveys is to use a self-administered questionnaire, which is usually mailed to the sample of people selected to be surveyed. This is a relatively inexpensive method of conducting a survey and is therefore attractive when the number of people to be surveyed is large. Compared to telephone and personal interviews, mail questionnaires have the disadvantage of low response rates and sample selection bias. The significance of these disadvantages can be reduced if the questionnaire is well designed. Studies in the past have found that non-response is often associated with lack of interest in the topic of the survey. Most of the other

shortcomings of mail surveys may be overcome if the respondents are familiar with the good being valued (Mitchell & Carson, 1993).

Given the large sample population chosen to obtain a wide range of answers to attitude questions and the financial and time constraints, the administration of a dichotomous choice format by mail survey CV was the best choice.

4.2.5 Questionnaire Design

Whether a questionnaire is self administered or completed by an interviewer, it must be well designed. In order to ensure the highest achievable response rates in the mail survey, we have adopted the elements of the Total Design Method (TDM) as described by Don Dillman (1978) in his procedures for implementing mail surveys. The theory underlying the TDM is social exchange, which suggests that the likelihood that individuals will respond to a survey questionnaire is a function of how much effort is required to respond, and what they feel they are likely to get in exchange for completing the questionnaire.

The basic elements and procedures of the TDM are:

- Minimise the burden on the respondent by designing questionnaires that are attractive in appearance and easy to complete; printing mail questionnaires in booklet format; placing personal questions at the end; creating a vertical flow of questions; and creating sections of questions based on their content.
- Personalise all communication with the respondent by printing letters and envelopes individually, using blue ball point pens for signatures and a first class stamp on outgoing and return envelopes; and constructing a persuasive letter.
- Provide information about the survey in a cover letter to respondents, interviewers, and clerical personnel. If possible, also send out letters in advance to informing respondents that a survey is forthcoming.
- Follow-up contacts of non-respondents are essential.

The professional image of the questionnaire is highly influential in enhancing the importance of the survey to the respondent. The end result must be aesthetically pleasing while maintaining question and page structure to keep respondents from skipping individual items or whole sections of the questionnaire.

An attempt was made to make the questionnaire as short as practicable. A covering letter was sent with every questionnaire giving an introduction and explaining the survey purpose. An explanation of the study topic, the benefit to the community of which the respondent is part, and the importance of the respondent to the survey's success, are all emphasised (Dillman, 1978). The letter was printed on Massey University letterhead to emphasise the non-commercial nature of the survey and the reputable stature of the institution from which the survey is conducted (see Appendix 4).

On the first two pages of the questionnaire, the background of the survey topic was given. This is informative and sets the scene for the rest of the survey. It provides respondents with a description of the flood control scheme, so they can start thinking about their own experiences, their values and their subjective risk of adverse effects from "inadequate" flood protection.

Clear instructions were provided for the completion of the questionnaire and attempts were made to design the questionnaire to avoid clutter. The questions were asked in a logical order and grouped into sections. Each section was introduced to allow the respondents to change mental gear. The questions were phrased as neutrally as possible, so as not to lead the respondents towards any particular answer. Sensitive questions (for example: about age or income) were placed towards the end of the questionnaire as they could alienate the respondent if placed in the beginning of the questionnaire. The questions were written in simple english to ensure clarity and avoid jargon, so that the recipient could easily understand them. Too many skip rules (for example: if you answered "Yes" to this Question, go to Question 10) can introduce confusion and make questionnaires more difficult to complete and for this reason were avoided as much as possible.

The tick boxes were made large enough for a good size tick and sufficient space was provided for written answers so that the respondents did not have to compress their writing. Respondents were also asked for comments on various questions. This helped capture points of concern to the respondents which were not covered in the questionnaire.

4.2.6 Survey reliability and validity

The single most effective way of enhancing a survey's reliability and validity and one of the principal means of reducing bias is pre-testing. Pre-testing can help avoid bias by making the questionnaire clearer and providing people with the information they need to make their decisions (Mitchell & Carson, 1993). The NOAA panel in their review on the validity of CVM have also emphasised the importance of exhaustive pre-testing of the survey instrument before the actual survey is conducted (Kolstad, 2000).

Using focus groups in one's pre-test helps to understand how and what people are valuing. Further samples should be split so that the dimension of a particular item in the questionnaire can be asked in different ways. It is then possible to test if the phrasing of the question affects the answer or value provided, but this adds to the number of completed surveys needed for statistical significance. The current state of the art favours mails surveys, but only if all the conditions of proper survey design are satisfied. There are three kinds of validity tests:

1. ***Content validity*** focuses on the wording of the questions in the actual survey.
2. ***Construct validity*** results when a survey's questions are consistent with economic theory.
3. ***Criterion validity*** relies upon comparisons with laboratory experiments.

For this study a pre-test pilot survey was sent out before the main survey. As specified by Dillman (1978), it comprised of checking the survey with professionals trained in the area of non-market valuation, those who were knowledgeable in the area of flood control (Environment Waikato staff) and the people in the area. This was done in order to firstly, test the questionnaire and to ascertain that all questions were answered in the required way and secondly, to obtain an indication of a range of bids that were to be used for the dichotomous choice willingness to pay question in the main survey. For this purpose the willingness to pay question in the pilot survey was open-ended. A total of 25 potential respondents were sent questionnaires. The last question in the pilot survey sought opinions on the structure and composition of the questionnaire. These questions acted as feedback to pinpoint potential problem areas that could be

modified in the main questionnaire prior to sending it out. The pilot survey was posted out on the 22nd June, 2001 with a cover letter and a freepost return envelope.

After two weeks, 10 of the questionnaires (40 percent) had been completed and returned while 2 (8 percent) were sent back having not found the address. Responses to the willingness to pay question ranged from $0 to $200

Table 4.1 Pilot survey Responses

Pilot Survey	Number	Proportion
Valid responses received	10	40 %
Responses not received	13	52 %
Returned having not found address	2	8 %
Total Questionnaires sent	25	100 %

4.2.7 Questionnaire Implementation

After an analysis of the responses and comments made by respondents in the pilot survey, the questionnaire was adjusted and finalised before it was sent to the sample population. The main questionnaire was posted on the 6th August 2001 with an introductory letter and a freepost return envelope. Envelopes and cover letters bore the official Massey University, School of Applied and International Economics logo, to promote a professional image and thus reinforce the importance of completing the questionnaire.

Table 4.2 shows the range of bid values and the corresponding number of questionnaires that were sent out to the households / businesses in the survey area. There was no particular formula used to determine the number to be assigned to each bid. It was however logical to assign a higher number of questionnaires to higher bids, as the probability of respondents' willingness to pay would decrease as the bid increases.

Table 4.2 Questionnaire distribution by Bid

Bid $x	Distribution of Questionnaire
1	10
5	15
10	25
15	50
20	50
25	50
30	50
35	50
40	50
50	50
60	50
70	60
90	65
110	70
150	75
200	80
	800

Two weeks after the questionnaire was posted, a reminder letter was sent out to all that had not responded to the survey. This resulted in an increased number of responses received back. Researchers have used a number of methods to increase response rates which includes another copy of the survey being posted out with the second reminder letter, the use of a registered letter with a replacement survey or the use of follow up phone calls to non-respondents (Dillman, 1978). The use of prepaid monetary incentives has been found to increase the response rate in surveys to the extent that they more than pay for themselves. Unfortunately monetary constraints did not allow any of these approaches to be undertaken.

In total 800 questionnaires were posted out however 24 (3 percent) were returned not finding the respective address or respondent. It was assumed that 776 reached the desired households. Of those receiving a questionnaire, 241 responded in some form giving a response rate of 31 percent. Given the monetary and time constraints limiting the amount and methods of non-respondents follow up, this response rate was acceptable as it is comparable with response rates gained by similar work (Omwenga, 1995; Dolan & Gilbert, 1996; Coursey, 1998). Of those responding to the survey, 166 refused to pay the bid offered, giving 77 useable responses. This accounts for 31.5

percent of those contacted in the survey. Twenty-nine respondents (3.63 percent) returned their questionnaires but refused to participate for various reasons.

Table 4.3 Main survey responses

Type of Response	Number of respondents	Proportion
Valid responses	241	30.100
Invalid Responses	3	0.375
Refused to respond because:		
Too old / ill health	2	0.250
Not concerned	5	0.625
Felt not part of area	7	0.875
Do not reside in area	10	1.250
Others	5	0.625
Could not find address	24	3.000
Non-responses	503	62.875
Total	800	100 %

4.3 Summary

In this chapter, the benefits from flood protection were discussed and the process of developing the survey questionnaire was explained in detail. The implementation of the survey was also discussed and the initial survey responses were presented. The next chapter presents the responses and findings of the survey.

Chapter 5
Survey Responses

5.0 Introduction

In this chapter the responses obtained from the Contingent Valuation survey are presented and discussed. The chapter shows how the data and people's perceptions regarding flood control in the area were compiled from the survey. The basic statistical information is presented.

5.1 Characteristics of respondents

Table 5.1 presents a summary of the socio-economic characteristics of the respondents. It shows that 67.6 per cent of the respondents were male and 32.4 per cent were female. The table indicates that farmers or dairy farmers in the area completed 41.7 per cent of the questionnaires, and 9.1 per cent of the respondents are retired. The table also shows that a large proportion of the returned questionnaires (38.3 per cent) were completed by respondents belonging to the over $60,000 income group. Apart from the over $60,000 income group, the households are almost equally distributed among the remaining income groups. The smallest proportion (4.7 per cent) came from the group with income less than $10,000.

Households with two members occur most frequently in the sample population, giving a proportion of 63 per cent (151 households). Seventy-five of the respondents (31.1 per cent) are in the 40 to 50 years age range, which is the largest age group. They are followed by the 50 to 60 year age group, where the number of respondents are 52 (21.6 per cent). The above 70 years age group that participated in the survey represented 6.2 per cent the respondents.

Table 5.1 Characteristics of respondents

Characteristics	Number of Respondents	Proportion
Gender of Respondents		
Female	78	32.4
Male	163	67.6
Occupation		
Farmer	78	32.4
Dairy Farmer	20	8.3
Retired	22	9.1
Other	121	50.2
Income		
Less than $10,000	10	4.7
$10,000 to $19,999	23	10.7
$20,000 to $29,999	23	10.7
$30,000 to $39,999	23	10.7
$40,000 to $49,999	26	12.1
$50,000 to $59,999	27	12.6
$60,000 and over	82	38.3
Age of respondent		
Less than 30 years	38	15.8
30 to 40 years	30	12.4
40 to 50 years	75	31.1
50 to 60 years	52	21.6
60 to 70 years	31	12.9
Above 70 years	15	6.2
Contributing towards income		
One person	53	22.0
Two people	151	63.0
More than two people	37	15.0

5.2 Familiarity with the Lower Waikato area

To establish the respondents' familiarity with the area, they were asked to indicate how long they had lived in the Lower Waikato area. The responses are summarised below in Table 5.2.

Approximately 23 per cent of the respondents had lived in the Lower Waikato area for 1 to 10 years. This was the largest group, followed closely by the 22 percent of the respondents who had lived in the area from between 11 to 20 years. Out of the sample population approximately 15 per cent of the respondents had lived in the area for more than 50 years.

Table 5.2 Time lived in the Lower Waikato

Time lived in Lower Waikato	Number of Respondents	Proportion
Less than 1 year	7	2.9
1 to 10 years	55	22.8
11 to 20 years	53	22.0
21 to 30 years	44	18.3
31 to 40 years	28	11.6
41 to 50 years	18	7.5
more than 50 years	36	14.9
Total	241	100.0

5.3 Property, flood experience and LWWCS awareness

To obtain information on the respondents relation with the property in the Lower Waikato area, they were asked to indicate whether they are the owners or the occupiers of the property.

The responses from the survey given in Table 5.3 indicate that the majority of the respondents in the area, i.e. 97.1 per cent, own the property, whereas only a very small proportion of the respondents (2.9 per cent), did not own the property.

Table 5.3 Owner or Occupier of property

Property	Number of Respondents	Proportion
Owner	234	97.1
Occupier	7	2.9
Total	241	100.0

In order to help find out how much flood protection is worth and whether the respondents knew what the situation would be like in the event of a flood, they were asked to indicate whether they had ever experienced a flood while living in the Lower Waikato.

Table 5.4 shows us that a large number of respondents to the survey have experienced a flood in the Lower Waikato area. Out of the sample population, about 70 per cent of the respondents indicated that they had experienced a flood in the Lower Waikato area, whereas about 30 per cent of the respondents indicated that they had not. This is good for our research as most of the respondents know what it is like to be in a flood situation. This makes it easier for them to indicate how much they value flood protection.

Table 5.4 Flood Experience

Experienced Flood	Number of Respondents	Proportion
Yes	169	70.1
No	72	29.9
Total	241	100.0

To find out whether the people in the Lower Waikato area knew about the existence of the LWWCS, they were asked to indicate if they were aware of the flood control scheme before reading the information provided in the survey.

Table 5.5 shows us that 78 per cent of the respondents were aware of the existence of the LWWCS before receiving the questionnaire, while 22 per cent did not know about the scheme's presence.

Table 5.5 Awareness of scheme

Aware of LWWCS	Number of respondents	Proportion
Yes	188	78.0
No	53	22.0
Total	241	100.0

5.4 Indirect benefit area classification

With the help of the land classifiers and valuers in the region, the indirect benefit area had been broken down into three different classes, i.e., indirect benefit areas: A, B and C. These areas had been classified based on proximity to the scheme area, elevation of land, land classifiers judgement etc.

A map of the scheme area including the indirect benefit area classification was sent along with each questionnaire. The respondents were asked to identify, by looking at the map, whether their property was in the indirect benefit area A, B or C.

The responses summarised in Table 5.6 show that 130 of the respondents (53.9 per cent) property was in indirect benefit area A. Eighty-five respondents (35.3 per cent) had property in indirect benefit area B, while 26 respondents (10.8 per cent) indicated that their property fell in indirect benefit area C.

Table 5.6 Indirect benefit area

Indirect Benefit Area	Number of Respondents	Proportion
A	130	53.9
B	85	35.3
C	26	10.8
Total	241	100

5.5 Direct benefit area reliance

In order to obtain information regarding people in the indirect benefit area and how often they use the area directly protected by the LWWCS, respondents were asked to indicate how often they rely on, visit, travel to or through the direct benefit area of the

scheme. Respondents were asked to tick whether they relied on the direct benefit area daily, weekly, monthly, yearly or never.

The responses, summarised in Table 5.7, show that 107 of the respondents (44.4 per cent) indicated that they relied on, visited, travelled to or through the direct benefit area on a daily basis. The daily reliance group was the largest, followed by the weekly reliance group where 98 respondents (40.7 per cent) indicated their weekly reliance on the direct benefit area. Twenty-eight respondents (11.6 per cent) indicated that they relied on the direct benefit area monthly, while 8 respondents (3.3 per cent) indicated that they relied on the direct benefit area on a yearly basis.

Table 5.7 Reliance on Direct benefit area

Reliance	Number of respondents	Proportion
Daily	107	44.4
Weekly	98	40.7
Monthly	28	11.6
Yearly	8	3.3
Never	0	0.0
Total	241	100.0

To obtain more information about the people in the indirect benefit area and their reliance on the area directly protected by the LWWCS, respondents were asked to indicate what different activities they relied on in the direct benefit area. They were given various options to tick in the questionnaire, which included activities such as work, school, shops, markets, hospital, pub and recreation. The questionnaire also asked the respondents to write down any other activities that they relied on.

Table 5.8 shows us that most people in the indirect benefit areas rely on the direct benefit area for shopping purposes i.e., 63.1 per cent, followed by 55.6 per cent for work. A large number of people in the indirect benefit area also rely on the direct benefit area for recreation purposes (46.5 per cent). Other activities some respondents undertake in the direct benefit area include going to church and social clubs.

Table 5.8 Activities for which people rely on the direct benefit area

Activities	Number of Respondents	Proportion
Work	134	55.6
School	53	22.0
Shops	152	63.1
Markets	54	22.4
Hospital	80	33.2
Pub	24	10.0
Recreation	112	46.5

5.6 Benefit from LWWCS

After informing the respondents about the role of the LWWCS in the area, they were then asked to indicate, based on what they knew about the scheme and the information the survey provided them with, whether they perceived to benefit from the LWWCS being in place.

According to the responses given in Table 5.9, approximately 57 per cent of the respondents did perceive to benefit from the LWWCS, whereas the remaining 43 per cent did not believe they received any benefit from the scheme.

Table 5.9 Perceive Benefit from scheme

Benefit	Number of Respondents	Proportion
Perceive Benefit from LWWCS	137	56.8
Perceive No Benefit from LWWCS	104	43.2
Total	241	100.0

A separate question was asked if the presence of the scheme (and hence the indirect benefits of secure access and communication as well as the nearness of increased economic activity) had allowed (or encouraged) them to change their land use, i.e., use land more intensively.

Table 5.10 indicates that the presence of the LWWCS allowed 17 respondents (7.1 per cent) to change their land use and use it more intensively. The remaining 224

respondents (92.9 per cent) did not change their land use due to the presence of the scheme.

Table 5.10 Respondents who changed land use due to the LWWCS

Changed land use due to LWWCS	Number of Respondents	Proportion
Yes	17	7.1
No	224	92.9
Total	241	100.0

Those who answered "yes" to the previous question, indicating that they did change their land use due to the presence of the LWWCS, were then further asked if they would have changed their land use if the flood control scheme had not been in place.

Table 5.11 shows that out of the 17 respondents that did change their land use due to the presence of the scheme, 15 of them (88.2 per cent) would not have made this change in the absence of the LWWCS.

Table 5.11 Would these people have changed their land use if there were no LWWCS

Change	Number of Respondents	Proportion
Yes	2	11.8
No	15	88.2
Total	17	100.0

5.7 Flood effect

In order to help us establish how much benefit people in the indirect benefit area receive from the scheme, we first needed to find out what kind of an effect a major flood would have on the respondents, if the direct benefit areas were fully affected by a flood. For this purpose the respondents were asked to indicate to what extent the occurrence of a major flood in the direct benefit area would affect them. A table of possible effects was provided for them to score from none to major effect. Some of the factors included were access, communication lines and peace of mind.

The summary of the responses are given in Table 5.12. Most respondents indicated that they would not be affected if a flood was to occur in the direct benefit area. The most significant effect the flood would have on the respondents would be their access to hospitals, major townships and work. People indicated that if a flood was to block their access to various places, they would consider the inconvenience a part of life and take an alternative route. The table also shows a minor effect on people's access to shops.

Table 5.12 The Effects of a flood on the respondents

Effect of a flood	None (%)	Minor (%)	Significant (%)
Access to work	123 (51.0)	49 (20.3)	69 (28.6)
Access to markets	131 (54.4)	61 (25.3)	49 (20.3)
Access to shops	109 (45.2)	75 (31.1)	57 (23.7)
Access to schools	166 (68.9)	34 (14.1)	41 (17.0)
Access to hospitals	99 (41.1)	64 (26.6)	78 (32.4)
Access to major townships	97 (40.2)	66 (27.4)	78 (32.4)
Communication lines	119 (49.4)	63 (26.1)	59 (24.5)
Access to recreational areas	145 (60.2)	57 (23.7)	39 (16.2)
Conservation areas	158 (65.6)	44 (18.3)	39 (16.2)
Peace of mind	122 (50.6)	57 (23.7)	62 (25.7)
Living standard	141 (58.5)	56 (23.2)	45 (18.7)

5.8 Importance of flood protection

In order to help establish how much flood protection is worth to the respondents, they were asked to indicate on a scale of 0 to 5 (0 being not important and 5 being very important), how important it is to them to avoid the negative impacts of a flood.

The responses in Table 5.13 show that 36.1 per cent of the respondents believe that it is very important to avoid the disruption of access to work, 27.8 per cent believe that it is very important to avoid the disruption of communication lines. Avoiding the disruption of access to hospitals is also considered very important by 24.5 per cent of the people. The avoidance of the disruption of access to shops is considered important to 23.2 of the respondents.

Table 5.13 The Importance of avoiding negative flood impacts

Importance of avoiding floods disrupting:	Not important		Important		Very Important	
	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Access to work	97 (40.2)	13 (5.4)	11 (4.6)	20 (8.3)	13 (5.4)	86 (36.1)
Access to school	142 (58.9)	17 (7.1)	11 (4.6)	24 (10.0)	9 (3.7)	38 (15.8)
Access to shops	85 (35.3)	26 (10.8)	31 (12.9)	56 (23.2)	10 (4.1)	33 (13.7)
Access to markets	125 (51.9)	24 (10.0)	17 (7.1)	33 (13.7)	9 (3.7)	33 (13.7)
Access to hospitals	80 (33.2)	19 (7.9)	26 (10.8)	40 (16.6)	17 (7.1)	59 (24.5)
Access to recreational areas	148 (61.4)	30 (12.4)	21 (8.7)	21 (8.7)	3 (1.2)	18 (7.5)
Access to major townships	106 (44.0)	30 (12.4)	22 (9.1)	39 (16.2)	11 (4.6)	33 (13.7)
Communication lines	67 (27.8)	17 (7.1)	24 (10.0)	46 (19.1)	20 (8.3)	67 (27.8)
Conservation areas	125 (51.9)	22 (9.1)	26 (10.8)	33 (13.7)	11 (4.6)	26 (10.8)
Peace of mind	93 (38.6)	24 (10.0)	26 (10.8)	33 (13.7)	18 (7.5)	47 (19.5)

5.9 Paying for flood control

To obtain information regarding respondents attitudes towards paying for flood protection, the respondents were asked to indicate whether they thought flood protection was actually worth paying for, or not.

Table 5.14 shows us that 152 respondents (63.1 per cent) believed that flood protection was in fact worth paying for, whereas 89 respondents (36.9 per cent) did not think so.

Table 5.14 Respondents attitude towards paying for flood protection. Their belief whether flood protection is worth paying for or not.

People's belief about flood protection being worth paying for	Number of Respondents	Proportion
Yes	152	63.1
No	89	36.9
Total	241	100.0

The main question of the survey was to ask the respondents whether they would be willing to pay a specified amount of money from between $0 to $200 for flood

protection. The respondents had to either agree or disagree to be willing to pay the offered amount.

Table 5.15 shows us that 75 respondents (31.1 per cent) agreed to pay the offered bid, whereas 166 respondents (68.9 per cent) disagreed to pay.

Table 5.15 People willing to pay the bid offered

People willing to pay the offered bid	Number of Respondents	Proportion
Yes	75	31.1
No	166	68.9
Total	241	100.0

5.10 Protesting respondents

The respondents who answered "no" to the previous question and refused to pay the offered bid, were then asked to indicate why they were not willing to pay the bid offered. Various reasons were provided which the respondents were required to tick if any of the reasons applied to them, and some space was provided for respondents wanting to write down other reasons.

The results provided in Table 5.16 indicate the main reason why respondents were not willing to pay the offered bid was because they believe they already pay enough in terms of rates or rent (44.4 per cent). This was followed by 63 of the respondents (26.1 per cent) wanting the Government or regional bodies to pay for the flood control scheme. Also, 53 respondents (22 per cent) believed that the direct beneficiaries should bear the cost of flood protection rather than the indirect beneficiaries. Out of the respondents not willing to pay the offered bid, 51 of them (21.2 per cent) did not want to pay the specified amount because they did not believe they received any benefit from the LWWCS.

Table 5.16 Reasons for not willing to pay

Reasons for not willing to pay	Number of respondents	Proportion
Should be paid by Govt / Regional bodies	63	26.1
Direct Beneficiaries should pay	53	22.0
Too many inefficiencies in the system	47	19.5
Already pay enough rates / rent	107	44.4
Disagree with the system	18	7.5
Prefer levy on rates	5	2.1
Need more information	29	12.0
Cannot afford to pay	29	12.0
Should not pay because do not receive benefit	51	21.2
Too much	21	8.7

5.11 Insurance

In order to understand respondents' attitudes towards paying for flood protection, they were asked to indicate whether they were insured against some flood contingencies. According to the responses given in Table 5.17, 23 respondents (9.5 per cent) indicated that they were insured against some flood contingencies, while the remaining 218 respondents (90.5 per cent) were not.

Table 5.17 Insurance against flood contingencies

Insured against flood contingencies	Number of Respondents	Proportion
Yes	23	9.5
No	218	90.5
Total	241	100.0

5.12 Comments

In the questionnaire, space was provided for the respondents to pass their comments on indirect flood protection from the LWWCS. A small number of respondents commented that rather than receiving a positive benefit from the LWWCS they received a negative benefit or a detriment from the LWWCS. This was because flood control techniques caused some of their land to become ponding areas.

5.13 Summary

This chapter has presented the responses and perceptions regarding indirect flood protection of the people in the Lower Waikato. The information was compiled with the help of the responses from the Contingent Valuation survey. In the next chapter this statistical information is used to conduct some econometric analysis to provide the decision-makers with clearer information.

Chapter 6
Model Selection, Estimation and Results

6.0 Introduction

The analysis of basic data is a vital part of providing decision makers with an improved information base. Responses obtained are transformed into clear and succinct information by using appropriate data analysis techniques, making the data useful for decision making purposes.

The chapter starts off by selecting an econometric model to analyse the data obtained from the dichotomous choice format of the contingent valuation method.

6.1 The Dichotomous Choice Model of Willingness to Pay

In recent years, increasing attention has been given to the statistical aspects of contingent valuation (CV) survey design and data analysis. The main reason for the growing interest in statistical issues is the shift in CV practice from using an open-ended question to ask about willingness to pay (WTP) to using a closed-ended question. The open-ended format confronts respondents with a question on the lines of "What is the most you would be willing to pay for ..?" The closed-ended format uses a question like "If it cost $X to obtain... , would you be willing to pay that amount?" The closed-ended format was introduced into CV by Bishop and Heberlein (1979). Since the mid-1980's it has gained widespread acceptance as the preferred way to cast the valuation question, a position that was recently endorsed by NOAA's Blue Ribbon Panel on CV (Arrow et al., 1993; Haneman & Kanninen, 1996).

For the purpose of this research the respondents are asked to answer "yes" or "no" to whether they are willing to pay an additional $X in rates or rent per year towards flood protection. The $X amount is called the "bid price", which varies from $1, $5, $15, $20, $25, $30, $35, $40, $50, $60, $70, $90, $110, $150 and $200.

The maximum willingness to pay for flood control is inferred from the pattern of yes and no responses to this question, which are taken as 1 and 0, respectively. This is done by estimating a function Y = f(X) that translates these one's and zero's, into a set of probabilities that vary as the bid prices vary.

When dealing with a dependent variable such as willingness to pay, the mathematical expectation is that the equation is a non-linear function of its independent variables (Aldrich & Forrest, 1984). For this reason Ordinary Least Squares (OLS) regression cannot be applied to the data, OLS is applicable only to linear models. To overcome the incompatibility of the data with OLS, non-linear probability models that are consistent with consumer utility maximisation theory should be employed such as the logit and probit models.

According to Obben et al. (2001) the logit and probit models are quite comparable and give qualitatively similar results. However, the logistic cumulative distribution function is not in integral form and that makes the logit model somewhat easier to work with (Griffiths et al., 1993). Gujarati (1995) in a note on "Logit vs. Probit" concludes that the logit model is generally preferred to the probit. Pindyck and Rubinfeld (1991) deem the logit model to be "somewhat more appealing" than the probit model. Therefore, the logit model was chosen to conduct the analysis.

6.2 The Logit Model

The logit model is the natural complement of the regression model in case the regressand is not a continuous variable but a state which may or may not obtain, or a category in a given classification (Cramer, 1991).

In the logit model, an index of behaviour is created which is specified as a linear function of a set of explanatory variables, one of which is the bid value. This index is then transformed into a probability by applying a cumulative density function. In our case we are attempting to model the probability of a "yes" response by a respondent as a function of the bid value and their socio-economic characteristics. This probabilistic approach to modelling behaviour derives from the "random utility model".

The consistency of the logistic model and the utility maximisation theory can be explained by relating the probability that a household will say "yes", that is they are willing to pay $X for flood protection, to the probability that the utility gained from the flood protection exceeds utility from the lost $X. It is presumed that the respondent compares having $X and no flood protection and the other situation having no $X, but having flood protection. If the difference in utility between the two situations is positive, the answer is expected to be "yes" (Loomis, 1988).

Following Gujarati (1995), the logistic model can be represented in the following manner. Consider the probability P_i of a respondent to answer "yes" to the willingness to pay question.

$$P_i = E(Y = \frac{1}{X_i}) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 X_i)}} \qquad (1)$$

Where

- E ($Y=1/X_i$) is the conditional expectation of Y given X_i,
- X_i is some independent variable such as household income,
- Y = 1 if the respondent responds with a "yes" to the willingness to pay question, and Y = 0 if the respondent says "no" to the willingness to pay question,
- e is the base of the natural logarithm,
- β_1 and β_2 are parameters that represent the intercept and the slope coefficient respectively.

The equation can be simplified to:

$$P_i = \frac{1}{1 + e^{-Z_i}} \qquad (2)$$

where

$$Z_i = \beta_i + \beta_2 X_i \qquad (3)$$

Equation (2) above is called the cumulative logistic distribution function. It is easy to verify that as Z_i ranges from $-\infty$ to $+\infty$, P_i ranges between 0 and 1 and that P_i is non-

linearly related to Z_i (i.e., X_i). An estimation problem seems to have been created because P_i is not only non-linear in X, but also in the β's as can be seen in equation (1). For this reason the OLS procedure cannot be used to estimate the parameters.

If P_i is the probability of saying "yes" to the willingness to pay question and is given by equation (2), then (1- P_i) the probability of saying "no", is:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \tag{4}$$

the odds in favour of saying "yes" to the offered bid can be written as:

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \tag{5}$$

Thus, if $P_i = 0.8$, it means that the odds are 4 to 1 in favour of saying "yes" to the bid offered.

Now taking the natural log of equation (5), the logit (L_i) is obtained:

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = Z_i = \beta_1 + \beta_2 X_i \tag{6}$$

This is the log of the odds ratio, which is linear in X and also in the parameters β.

According to Gujarati (1995) the logit model has the following features:

1. As P goes from 0 to 1, the logit L goes from -∞ to +∞. This means that even though the probabilities are bounded to fall between 0 and 1, the logit is not.
2. Although L is linear in X, the probabilities themselves are not.
3. β_1 is the intercept which represents the value of the log-odds in favour of responding "yes" if the suggested value is zero; β_2 is the slope of the graph, which is a measure of the change in L for a unit change in X. This tells us how the log-odds in favour of saying "yes" changes as X changes by a unit.

By plotting the predicted probabilities derived from the logistic regression function in equation (6), the inverse cumulative regression function is gained. The area under the curve is the expected maximum willingness to pay for those in the sample. Mathematically, the expected value is the integral of the cumulative distribution

Function:

$$WTP = \int_{1}^{\infty} \left[1 - \frac{1}{1+e^{x}} \right] dx \qquad (7)$$

Using an econometric package such as SHAZAM allows the beta coefficients to be estimated by finding the "best fit" of the data to the logistic functional form.

6.2.1 Logit Model Estimation

In the dichotomous choice response question, every individual was offered only one bid. Each respondent was required to respond either "yes" or "no", to indicate his or her willingness to pay that amount in extra rates or rent, towards flood protection in the Lower Waikato. The responses to each bid are summarised in the table below.

Table 6.1 Bid and corresponding responses

Bid $x	Questionnaires Sent	Number Received	Proportion Received	Yes Responses	% Yes P	No Responses	% No (1-P)
1	10	4	40.0	1	25.0	3	75.0
5	15	2	13.3	0	0.0	2	100.0
10	25	6	24.0	4	66.6	2	33.3
15	50	9	18.0	3	33.3	6	66.7
20	50	20	40.0	6	30.0	14	70.0
25	50	18	36.0	4	22.2	14	77.8
30	50	18	36.0	8	44.4	10	55.6
35	50	14	28.0	6	42.9	8	57.1
40	50	15	30.0	7	46.6	8	53.3
50	50	17	34.0	3	17.7	14	82.4
60	50	17	34.0	5	29.4	12	70.6
70	60	19	31.7	10	52.6	9	47.4
90	65	24	36.9	8	33.3	16	66.7
110	70	17	24.3	4	23.5	13	76.5
150	75	21	28.0	3	14.3	18	85.7
200	80	20	25.0	3	15.0	17	85.0
	800	241		75		166	

6.2.1.1 Univariate Logistic regression analysis

We start off by applying a logistic regression procedure to the data given above. The respondents' willingness to pay (WTP) is the dependent variable, and the corresponding offered bid value (BID) is taken as the independent variable. As the dependent variable is binary, the value of a "yes" response is taken as 1, while a "no"

response is taken as 0. The values of β_1 and β_2 were found to be -0.34962 and -0.0063585 respectively.

Substituting these values into equation (6), we get:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = -0.34962 - 0.0063585X_i \qquad (8)$$

6.2.1.2 Multivariate Logistic regression analysis

It is expected that the bid will not be the only variable that may influence a respondent's willingness to pay. For this reason it is then required to investigate other factors that are likely to influence one's willingness to pay. The set of independent variables from which the models were selected were: BID, DURA, OWN, EXP, AWARE, INDA, RELY, BENEFIT, CHANGE, EFFECT, IMPT, WORTH, INS, MALE, AGE, FARM, INC, SING. The dependent variable is WTP (willing to pay), when the respondent says "yes" to paying the bid offered.

The independent variables are:

BID	Bid offered
DURA	Lived in the Lower Waikato area for more than 20 years
OWN	Owner of the property
EXP	Experienced a flood
AWARE	Aware of the existence of the LWWCS
INDA	Property falls in indirect benefit area A
RELY	Rely on the direct benefit area daily
BENEFIT	Perceives to receive benefit from the LWWCS
CHANGE	Changed land use due to presence of the scheme
EFFECT	Effected by flood occurring in direct benefit area
IMPT	Believes it is important to avoid negative flood impacts
WORTH	Believes flood protection is worth paying for
INS	Insured against some flood contingencies
MALE	Respondent is a male
AGE	Respondent is over 40 years old
FARM	Respondent is a farmer

INC	Yearly income is more than $40,000
SING	Only one person contributing to household income

The variables to be included in the logistic regression model can be selected by entering variables one thinks will be good predictors, however there are various techniques whereby variables are added or eliminated from the model based on statistical significance. Three such methods are the stepwise selection, the forward stepwise selection and the backward stepwise selection methods.

Statistical Tests

t-statistic

The t-ratio gives the statistical level of significance of the explanatory variables in the presence of other explanatory variables. The t-ratio that corresponds with an alpha of 0.05 under the null hypothesis that the true value of the coefficient is zero is chosen. The variable with the highest t-ratio is selected and is added to the model. All the remaining variables are similarly estimated with the constant variable and previously selected variables. This process is repeated until no more significant variables can be added to the model.

Other tests that were undertaken to select the best model included the Wald statistic test, the log likelihood, chi-squared test and the percent right prediction test.

McFadden R-Squared

The McFadden R-squared describes the proportion of variation in the dependent variable that can be described by the explanatory variables. It can be interpreted in a similar manner as the correlation of determination R-squared (McFadden, 1974).
It can be calculated as:

$$R^2 = 1 - \frac{(\log \beta_{m1})}{(\log L_0)}$$

where:

$\log \beta_{m1}$	is the sum of the estimated parameters for the model,
$\log L_0$	is the estimated parameter for the intercept.

The McFadden R-square is automatically generated by the logit command of the SHAZAM output along with the Maddala and Cragg-Uhler R-squares.

Chi-Square Statistic

The chi-square statistic is used to measure the likelihood that outcomes from cross tabulations occur purely by chance. It is presented with a statistic that describes the probability of obtaining a chi-square value as large as the one obtained by chance alone.

It can be calculated as:

$$\chi^2 = \sum_{i=1}^{\infty} \frac{\left[(O_i - E_i)^2\right]}{E_i}$$

where:

O_i is the observed outcome from a cell

E_i is the expected outcome from a corresponding cell.

The model chi-square tests the null hypothesis that the coefficients for all the terms in the model except the constant are zero. This value is comparable to the overall F-test for the regression.

Percentage Right Prediction

The percentage correct prediction statistic assesses how well the model classifies the observed data by comparing observed outcomes to predicted outcomes. The comparisons are expressed in the form of a 2x2 frequency table of the observed and predicted responses. In the case of the actual data, an event is considered to occur if the respondent says 'yes' to the willingness to pay question. For the predicted data, an event is considered to occur if the probability of the respondent being willing to pay (WTP) at least 50 percent (Norusis, 1992).

6.3 Model Selection

6.3.1 Forward Selection

In the forward stepwise selection process in logistic regression, the model is initially estimated with only the constant variable. Predictor variables are added to the model a step at a time. The first step evaluates all of the variables, and the variable with the

largest correlation with the dependent variable is entered first. Then on each new step, the variable which has the largest t-ratio or will increase R-square the most will be entered on that step.

6.3.1.1 Initial Model

The initial model is run only with the constant. From table 6.2 we can see that the coefficient on the constant has a t-statistic equal to -5.5919, which is significant at the 0.01 level (99% confidence level) with a critical value of 46.72 [df=1].

Table 6.2 The initial model

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*
Constant	-0.77521	0.13863	-5.59190	31.26974

McF. R-square 0.00000

Log likelihood -150.22000

Table 6.3 Variables not included in the initial model

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*	*McF. R-sq*
BID	-0.00636	0.00279	-2.27690	5.18432	0.01883
DURA	0.02046	0.27760	0.07371	0.00543	0.00002
OWN	0.14518	0.84772	0.17126	0.02933	0.00010
EXP	-0.02697	0.30228	-0.08923	0.00796	0.00003
AWARE	-0.21357	0.32625	-0.65463	0.42853	0.00141
INDA	-0.46361	0.27888	-1.66240	2.76357	0.00924
RELY	0.48564	0.27912	1.73990	3.02724	0.01011
BENEFIT	1.78500	0.34246	5.21220	27.16794	0.10995
CHANGE	1.08970	0.49648	2.19490	4.81737	0.01599
EFFECT	0.93909	0.28508	3.29410	10.85128	0.03719
IMPT	0.89542	0.29425	3.04310	9.26021	0.03237
WORTH	2.46880	0.45114	5.47240	29.94671	0.15551
INS	-0.05684	0.47594	-0.11942	0.01426	0.00005
MALE	0.55769	0.31524	1.76910	3.12970	0.01087
AGE	0.14135	0.28110	0.50283	0.25285	0.00084
FARM	0.48087	0.28049	1.71440	2.93914	0.00978
INC	0.67658	0.28957	2.33650	5.45923	0.01875
SING	0.03197	0.33361	0.09583	0.00918	0.00003

We can see from the table that the variable WORTH is significant compared to all other variables as it has a higher t-ratio, Wald statistic and McFadden R-square. Therefore, in the next step we add the WORTH variable to the model and then

estimate it with each remaining independent variable separately, in order to similarly extract other significant variables to add to the model.

6.3.1.2 Model 1

The results from Model 1 indicate that the respondents behave rationally. If a respondent believes that flood protection is worth paying for then they are more likely to be willing to pay towards the yearly maintenance of the scheme. The coefficient on the WORTH variable has a t-statistic equal to 5.4724 which is significant at the 0.01 level (99% confidence level) with a critical value of 46.72 [df=1]. The overall model is significant at the 0.01 level according to the chi-square statistic. The model predicts 68% of the responses correctly. The McFadden's R^2 is 0.1556.

Table 6.4 Variables in model 1

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*
Constant	-2.62700	0.42076	5.47240	38.98085
WORTH	2.46880	0.45114	5.47240	29.94671

McF. R-square	0.15551
Log likelihood	-126.86000
Chi-square statistic	29.9473

Table 6.5 Variables not included in model 1

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*	*McF. R-sq*
BID	-0.00694	0.00304	-2.28040	5.20042	0.17413
DURA	0.00525	0.30394	0.01728	0.00030	0.15551
OWN	0.58630	0.87326	0.67140	0.45077	0.15709
EXP	-0.00690	0.33073	-0.02086	0.00044	0.15551
AWARE	-0.15521	0.35727	-0.43444	0.18873	0.15613
INDA	-0.63703	0.30908	-2.06110	4.24794	0.16983
RELY	0.19872	0.30551	0.65046	0.42309	0.15691
BENEFIT	1.32660	0.36438	3.64080	13.25473	0.20400
CHANGE	0.54972	0.51452	1.06840	1.14151	0.15935
EFFECT	0.47793	0.31192	1.53220	2.34770	0.16334
IMPT	0.33596	0.32715	1.0269	1.05458	0.15903
INS	-0.21559	0.51108	-0.42184	0.17794	0.15611
MALE	0.62261	0.34099	1.82590	3.33387	0.16696
AGE	0.22121	0.30751	0.71935	0.51748	0.15724
FARM	0.87920	0.32233	2.72760	7.44002	0.18096
INC	0.66626	0.31507	2.11470	4.47171	0.17071
SING	0.00816	0.36485	0.02237	0.00050	0.15551

We can see from the table that the variable BENEFIT is significant compared to all other variables as it has a higher t-ratio, Wald statistic and McFadden R-square. In the next step we therefore add the BENEFIT variable to the model which already consists of WORTH and the constant. We then continue to estimate the model with the remaining independent variable separately, to find other significant variables which can be added to the model.

6.3.1.3 Model 2

This model includes an additional theoretically important independent variable: BENEFIT. According to the likelihood ratio test statistic, Model 2 is superior to Model 1 in terms of overall model fit. The chi-square statistic is significant at the 0.01 level (critical value = 61.2883 with 2 degrees of freedom), the percentage of correct predictions increases by 3 percent, and the McFadden's-R^2 is also larger. The coefficients on the WORTH and BENEFIT variables are statistically significant at the 0.01 level.

Table 6.6 Variables in model 2

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*
Constant	-3.23830	0.48129	-6.72830	45.27104
WORTH	2.10730	0.46527	4.52920	20.51364
BENEFIT	1.32660	0.36438	3.64080	13.25473

McF. R-square	0.20400
Log likelihood	-119.58000
Chi-square statistic	38.79050
Percentage Right predictions	0.7173897

Table 6.7 Variables not included in model 2

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*	*McF. R-sq*
BID	-0.00777	0.00322	-2.41490	5.83184	0.22508
DURA	-0.06625	0.31653	-0.20929	0.04380	0.20414
OWN	0.76238	0.89558	0.85126	0.72466	0.20655
EXP	-0.27845	0.35586	-0.78246	0.61226	0.20604
AWARE	-0.33977	0.37730	-0.90053	0.81095	0.20669
INDA	-0.64748	0.32166	-2.01290	4.05190	0.21771

RELY	-0.10029	0.32793	-0.30584	0.09353	0.20431
CHANGE	0.23188	0.52517	0.44154	0.19495	0.20465
EFFECT	0.24191	0.32814	0.73723	0.54349	0.20580
IMPT	0.05807	0.34783	0.16694	0.02787	0.20409
INS	-0.31892	0.52441	-0.60815	0.36985	0.20525
MALE	0.43533	0.35529	1.22530	1.50131	0.20907
AGE	0.17464	0.32062	0.54468	0.29669	0.20499
FARM	0.75822	0.33324	2.27530	5.17698	0.22157
INC	0.52462	0.32701	1.60430	2.57376	0.21265
SING	0.07597	0.38078	0.19950	0.03980	0.20413

We can see from the table that the BID variable has a higher t-ratio, Wald statistic and McFadden R-square and is therefore significant compared to all other variables. We therefore now add the BID variable to the existing model which already consists of the variables: BENEFIT, WORTH and the constant. The model continues to be estimated with all remaining independent variables until no significant variables remain.

6.3.1.4 Model 3

Model 3 includes another additional theoretically important independent variables which is BID. According to the likelihood ratio test statistic, Model 3 is superior to Model 1 and 2 in terms of overall model fit. The chi-square statistic is significant at the 0.01 level giving a critical value of 67.6233 with 3 degrees of freedom. The percentage of correct predictions increases to 73.86 percent, and the McFadden's-R^2 value is slightly larger. The coefficients on the WORTH, BENEFIT and BID variables are also statistically significant at the 0.01 level.

Table 6.8 Variables in model 3

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*
Constant	-2.76900	0.51040	-5.42510	29.43233
WORTH	2.12210	0.46895	4.52520	20.47758
BENEFIT	1.38360	0.37142	3.72510	13.87684
BID	-0.00777	0.00322	-2.41490	5.83184

McF. R-square	0.22508
Log likelihood	-116.41000
Chi-square statistic	42.0551

Percentage Right predictions 0.733470

Table 6.9 Variables not included in model 3

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*	*McF. R-sq*
DURA	-0.03968	0.32242	-0.12308	0.01515	0.22513
OWN	0.83065	0.91927	0.90359	0.81649	0.22795
EXP	-0.22189	0.36425	-0.60916	0.37109	0.22632
AWARE	-0.30782	0.38514	-0.79925	0.63879	0.22720
INDA	-0.72651	0.33100	-2.19490	4.81756	0.24151
RELY	-0.07464	0.33382	-0.22360	0.04999	0.22525
CHANGE	0.19032	0.53636	0.35483	0.12591	0.22550
EFFECT	0.19009	0.33453	0.56824	0.32289	0.22615
IMPT	0.15229	0.35579	0.42803	0.18321	0.22569
INS	-0.30330	0.52751	-0.57497	0.33059	0.22620
MALE	0.32966	0.36385	0.90604	0.82090	0.22784
AGE	0.13429	0.32622	0.41163	0.16946	0.22565
FARM	0.62961	0.34272	1.83710	3.37493	0.23642
INC	0.45998	0.33339	1.37970	1.90359	0.23146
SING	0.08048	0.38831	0.20726	0.04296	0.22522

We can see from the table that the INDA variable has a higher t-ratio, Wald statistic and McFadden R-square and is therefore significant compared to all other variables.

Table 6.10 Prediction success table for model 3

		ACTUAL		
		Not WTP	**WTP**	**Total**
PREDICTED	**Not WTP**	129	27	156
	WTP	36	49	85
	Total	165	76	241

Out of the 241 observations, the actual number of 'Not WTP' responses were 165 (i.e., 68.5 percent = (165/241)*100), whereas the number of 'WTP' responses were 76 or 31.5 percent. The model predicted 156 responses (64.7 percent) as 'Not WTP' and 85 (35 percent) as 'WTP'. Since the model predicted 156 'Not WTP' responses compared to the actual 165, we can say that the model under predicted by 9.

The table shows that the model correctly predicted 129 responses as 'Not WTP'. This amounts to 78.2 percent ((129/165)*100) of the total number of respondents that refused to pay the bid offered ('Not WTP). The model correctly predicted a total of 49

respondents that were willing to pay the bid offered ('WTP'). Thus, 64.5 percent ((49/76)*100) of those who were 'WTP', were correctly predicted.

A total of 63 observations (26.14 percent) were incorrectly predicted. Thirty-six respondents that said 'Not WTP' were incorrectly predicted by the model as being 'WTP' (21.8 percent). Also, 27 respondents that said 'WTP' were incorrectly predicted as 'Not WTP' (35.5 percent). Overall, 73 percent of the 241 observations were correctly predicted

Based on the various tests conducted, the INDA variable is added to the existing model which already consists of the variables: BID, BENEFIT, WORTH and the constant. The model is then once again estimated with all remaining independent variables to extract more significant variables.

6.3.1.5 Model 4

The final model includes the last significantly important independent variable: INDA. According to the likelihood ratio test statistic, Model 4 is superior to all previous models in terms of overall model fit. The chi-square statistic is significant at the 0.01 level (critical value = 72.5594 with 4 degrees of freedom). Although the percentage of correct predictions does not increase and remains at 73.86 percent, the McFadden's-R^2 value increases from 0.2251 to 0.2415. The coefficients of the variables are statistically significant at the 0.01 level.

Table 6.11 Variables in model 4

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*
Constant	-2.4315	0.53342	-4.5582	20.77830
WORTH	2.23200	0.47800	4.66950	21.80382
BENEFIT	1.38210	0.37475	3.68820	13.60178
BID	-0.00847	0.00332	-2.55290	6.51756
INDA	-0.72651	0.33100	-2.19490	4.81756

McFadden R-square	0.24151
Log likelihood	-113.94000

Chi-square stat	43.606644
Percentage Right predictions	0.7395567

Table 6.12 Variables not included in model 4

Variable	*Est. Coeff*	*Std. Error*	*t-ratio*	*Wald stat*	*McF. R-sq*
DURA	-0.03016	0.32673	-0.09231	0.00852	0.24154
OWN	0.66610	0.94161	0.70741	0.50042	0.24325
EXP	-0.29093	0.36865	-0.78918	0.62280	0.24359
AWARE	-0.30427	0.39080	-0.77859	0.60619	0.24352
RELY	-0.09131	0.33959	-0.26888	0.07229	0.24175
CHANGE	0.08615	0.55290	0.15581	0.02428	0.24159
EFFECT	0.19603	0.33917	0.57796	0.33405	0.24262
IMPT	0.17873	0.36276	0.49268	0.24275	0.24232
INS	-0.24837	0.52566	-0.47249	0.22325	0.24227
MALE	0.26881	0.36888	0.72870	0.53103	0.24329
AGE	0.05483	0.33238	0.16495	0.02721	0.24160
FARM	0.54676	0.34545	1.58270	2.50509	0.24991
INC	0.46560	0.33762	1.37910	1.90182	0.24789
SING	0.15131	0.39643	0.38169	0.14568	0.24200

We can see from the above table that there are no more significant variables at the 5 percent level. Hence we do not add any more variables to the model. Our final model therefore consists of the variables: INDA, BID, BENEFIT, WORTH and the constant.

Table 6.13 Prediction success table for model 4

		ACTUAL		
		Not WTP	**WTP**	**Total**
PREDICTED	**Not WTP**	134	32	166
	WTP	31	44	75
	Total	165	76	241

The model predicted 166 responses (68.9 percent) as 'Not WTP' and 75 (31 percent) as 'WTP'. Since the model predicted 166 'NotWTP' responses compared to the actual 165, we can say that the model over-shot by one.

The table shows that the model correctly predicted 134 responses as 'Not WTP'. This amounts to 81 percent ((134/165)*100) of the total number of respondents that refused to pay the bid offered ('Not WTP). The model correctly predicted a total of 44

respondents that were willing to pay the bid offered ('WTP'). Thus, 57.9 percent ((44/76)*100) of those who were 'WTP', were correctly predicted.

A total of 63 observations (26 percent) were incorrectly predicted. Thirty-one respondents that said 'Not WTP' were incorrectly predicted by the model as being 'WTP' (18.8 percent). Also, 32 respondents that said 'WTP' were incorrectly predicted as 'Not WTP' (42 percent). Overall, 74 percent of the 241 observations were correctly predicted.

6.3.2 Backward Selection

The backward selection proceeds in the opposite manner to forward selection. All variables are entered and then the poorest predictor is eliminated. The process continues until all of the non-significant variables are removed. Usually by default variables that are not significant are removed on each step, but any p-value or F-value can be used for the criteria. The model is re-evaluated after each variable is removed. This process is repeated until only significant variables remain.

The first step of the backward stepwise selection process involved estimating the model with all the variables. After the estimation, the most insignificant variable from the model is eliminated and the model is then estimated again. From table 6 we can see that the most insignificant variable is CHANGE. Therefore, the CHANGE variable is removed. The model is estimated again and the next most insignificant variable is eliminated. This process was continued until only significant variables remained.

Table 6.14 Estimated model containing all variables

Variable	*Est. Coeff*	*Std. Err*	*t-ratio*	*Wald stat*
BID	-0.00679	0.00349	-1.94290	3.77487
DURA	0.08848	0.37972	0.23301	0.05429
OWN	0.74908	0.97364	0.76936	0.59192
EXP	-0.42007	0.41793	-1.00510	1.01027
AWARE	-0.48348	0.43556	-1.11000	1.23214
INDA	-0.67229	0.34900	-1.92630	3.71076
RELY	-0.12195	0.36976	-0.32981	0.10877
BENEFIT	1.35080	0.42028	3.21410	10.33010
CHANGE	0.01193	0.58612	0.02035	0.00041
EFFECT	0.08188	0.43134	0.18984	0.03604
IMPT	0.30972	0.47166	0.65666	0.43120

WORTH	2.28530	0.50838	4.49520	20.20736
INS	-0.54116	0.56353	-0.96031	0.92218
MALE	0.17625	0.39151	0.45018	0.20266
AGE	0.01477	0.36930	0.03999	0.00160
FARM	0.56864	0.37489	1.51680	2.30074
INC	0.47714	0.36252	1.31620	1.73232
SING	0.29699	0.41885	0.70908	0.50277
Constant	-3.54920	1.20420	-2.94750	8.68688

In the end only four significant variables remained, namely: INDA, BID, BENEFIT and WORTH.

6.3.3 Stepwise Selection

The stepwise selection process uses a combination of the forward and backward stepwise selection processes. Predictor variables are entered as they are in forward selection, but at each step the variables are evaluated to see if any can be removed. On their own, forward and backward procedures are rarely used anymore, because stepwise selection is considered superior to both (Pope & Webster, 1972; Freedman, 1983). The results of the forward and backward stepwise selection process gave us the same final model.

6.4 Logistic Regression Results

The dependent variable, which measures the willingness to pay for indirect flood protection at different bid values, is WTP. The WTP response is equal to 1 if the respondent would be willing to pay the offered bid and 0 otherwise. Since the dependent variable is discrete, the ordinary least squares regression can be used to fit a linear probability model. However, since the linear probability model is heteroskedastic and may predict probability values beyond the (0,1) range, the logistic regression model is used to estimate the factors which influence willingness to pay behaviour (Stynes & Peterson, 1984; Greene, 1997).

Table 6.15 gives us a summary of the results of the logistic regression conducted for each model.

Table 6.15 Logistic Regression Results

	Constant	WORTH	BENEFIT	BID	INDA	McF R-Sq	Chi-Sq (df)	% Right
Model # 1								
Coefficient	-2.627	2.4688				0.15551	29.9473 (1)	0.68465
t-ratio	-6.2435	5.4724						
Model # 2								
Coefficient	-3.2383	2.1073	1.3266			0.204	38.7905 (2)	0.70954
t-ratio	-6.7283	4.5292	3.6408					
Model # 3								
Coefficient	-2.769	2.1221	1.3836	-0.0078		0.22508	42.0551 (3)	0.73859
t-ratio	-5.4251	4.5252	3.7251	-2.4149				
Model # 4								
Coefficient	-2.4315	2.232	1.3821	-0.0085	-0.7265	0.24151	43.6066 (4)	0.73859
t-ratio	-4.5582	4.6695	3.6882	-2.5529	-2.1949			

6.5 Assessment of selected model

The final model that has been selected with the help of the stepwise selection process consists of INDA, BID, BENEFIT, WORTH and the constant.

Given the coefficients, the logistic equation for the probability of the WTP can be written as:

$$prob(WTP) = \frac{1}{1 + e^{-Z}}$$

Where:

WTP = Z =

- 2.432 + 2.232 (WORTH) + 1.382 (BENEFIT) - 0.00847 (BID) - 0.727 (INDA) (9)

Applying this to an individual who believes that, (1) flood protection is worth paying for (coded as 1), (2) perceives to receive benefit from the LWWCS (coded as 1), and (3) lives in indirect benefit area A (coded as 1), if this individual is asked to pay the various different bids for flood protection, the corresponding probabilities of their WTP can be calculated as below:

Table 6.16 The probability of willingness to pay the bid offered

Bid $x	*Z*	*Probability*
1	0.4476	0.3899
5	0.4138	0.6020
10	0.3714	0.5918
15	0.3291	0.5815
20	0.2868	0.5712
25	0.2444	0.5608
30	0.2021	0.5504
35	0.1598	0.5399
40	0.1174	0.5293
50	0.0328	0.5082
60	-0.0519	0.4870
70	-0.1365	0.4659
90	-0.3059	0.4241
110	-0.4752	0.3834
150	-0.8138	0.3071
200	-1.2371	0.2249

If the estimated probability of WTP is less than 0.5, we predict that the individual will be unlikely to be willing to pay the offered bid. Based on this criterion, the table indicates that such an individual would be willing to pay not more than to $50, towards flood protection.

6.6 Estimation of Willingness to Pay

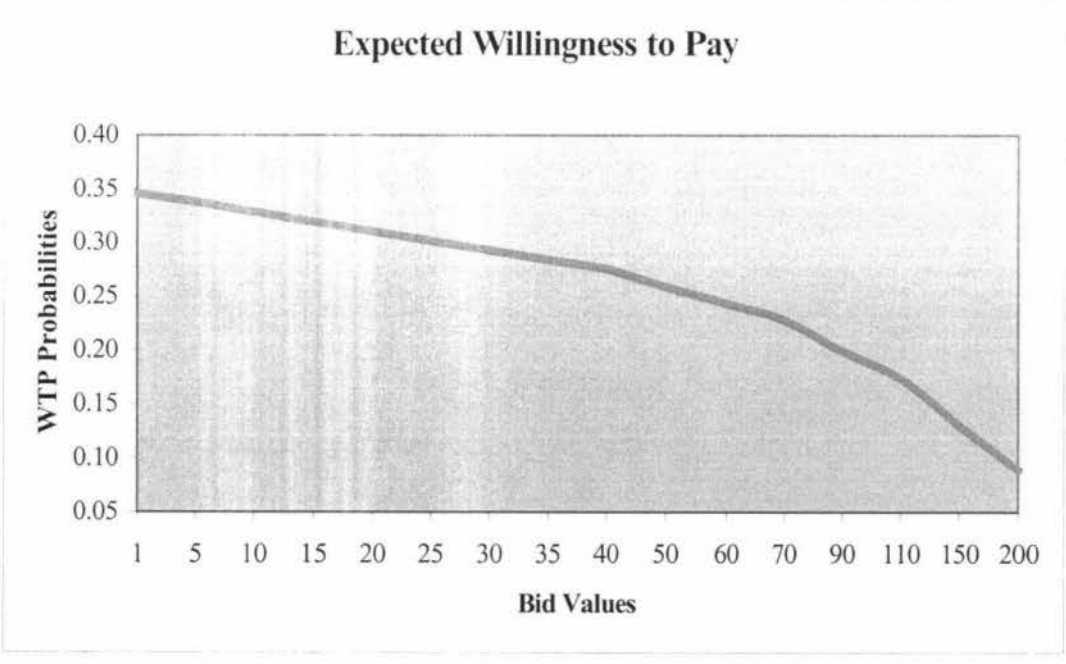
The estimation of the mean willingness to pay was conducted by plotting the probability of WTP against the bid offered. The expected willingness to pay is equal to the area under the curve (Kerr, 1986). To infer the maximum WTP for flood protection, we needed to calculate the likelihood of a 'yes' response to the willingness to pay question as a function of the bid offered and the characteristics of the respondent. For example, the probability of an average respondent being willing to pay $10 can be calculated by substituting it for the BID value in equation (9).

For the average respondent being asked a bid value ranging from $1 to $200, the corresponding probabilities of WTP are given below:

Table 6.17 WTP for flood protection in the indirect benefit areas A, B and C combined.

Bid $x	$\beta_1+\beta_2 x_1$	Anti-log	Prob (P_i)	Triangulation
1	-0.6384	0.5281	0.3456	0.0152
5	-0.6723	0.5106	0.3380	0.0611
10	-0.7146	0.4894	0.3286	0.1066
15	-0.7569	0.4691	0.3193	0.1506
20	-0.7993	0.4497	0.3102	0.1932
25	-0.8416	0.4310	0.3012	0.2341
30	-0.8839	0.4132	0.2924	0.2734
35	-0.9262	0.3960	0.2837	0.3111
40	-0.9686	0.3796	0.2752	0.7287
50	-1.0532	0.3488	0.2586	0.8585
60	-1.1379	0.3205	0.2427	0.9741
70	-1.2226	0.2945	0.2275	2.2419
90	-1.3919	0.2486	0.1991	2.5377
110	-1.5612	0.2099	0.1735	5.5919
150	-1.8998	0.1496	0.1301	7.1170
200	-2.3232	0.0980	0.0892	
			Mean WTP	**21.3951**

The area under the curve was estimated by triangulation to give the mean WTP for indirect flood protection. The mean WTP for the entire indirect benefit area (Indirect benefit areas A, B and C combined) was estimated to be $21.40.



The mean WTP has also been calculated separately for the indirect benefit area A and indirect benefit area B and C combined. The mean WTP for indirect benefit area 'A' has been estimated at $16.91. This was done by estimating the selected model and

then using the same process to estimate the WTP curve and the mean WTP. The mean WTP for indirect flood protection in indirect benefit area 'B and C' combined is estimated at $27.14.

Table 6.18 Indirect benefit areas mean willingness to pay

Area	Mean WTP
Indirect benefit area (A, B and C combined)	$21.40
Indirect benefit area A	$16.91
Indirect benefit areas B and C combined	$27.14

6.7 Summary

In this chapter an econometric model was selected which was then used for data analysis. From the information compiled from the survey, significant variables were added to the econometric model using different selection techniques. The mean willingness to pay for indirect flood protection was then estimated.

Chapter 7
Summary, Conclusion and Recommendations

7.1 Summary

The main focus of this dissertation was on the indirect benefits from flood protection in the Lower Waikato area. The study addressed a number of questions, namely the value that people in the area place on flood protection, whether or not people with differing characteristics placed different values on indirect flood protection and how people in the area felt about paying towards indirect flood protection. Its main objective however, was to quantify the indirect benefits from the LWWCS.

The first objective of this research was to select an appropriate methodology for evaluating the indirect benefits from flood protection in the Lower Waikato. After a detailed study of the various non-market valuation techniques, the Dichotomous Choice format of the Contingent Valuation Method was chosen to be the most appropriate technique, and it was conducted in the form of a self-administered mail survey.

The Contingent Valuation survey was sent to a random sample of residents in the indirect benefit area. Of those receiving the survey 31 percent returned a completed survey questionnaire. The survey collected information on people's opinions and attitudes towards paying for flood control, their use of the directly protected floodplain area, people's willingness to pay towards indirect flood protection and socioeconomic details about the respondents and their household. The responses indicated that 45.8 percent of the respondents relied on the directly protected floodplain daily, compared to 40 percent who relied on the floodplain on a weekly basis. A total of 78.4 percent of the respondents were aware of the existence of the LWWCS before receiving the survey questionnaire. The responses from the survey also indicated that 55.8 percent of the respondents believed that they benefited from the existence of the LWWCS. Of the respondents who were not willing to pay the bid

offered, 43.2 percent of them indicated their reason as being 'already paying enough rates'. From the total number of respondents 32.6 percent agreed to pay the bid offered to them.

The results of the Contingent Valuation survey indicated a high degree of awareness of the LWWCS, a low level of benefit perceived by the indirect beneficiaries and a willingness to pay for indirect flood protection. The results also indicated that the most significant factors which influenced respondents willingness to pay for indirect flood protection were, the respondents believing whether flood protection is worth paying for or not, the respondents perceiving to benefit from the LWWCS, the bid offered and the indirect benefit area that their property falls in. What the results indicate is that, a respondent who believes that flood protection is worth paying for, perceives to benefit from the scheme and falls in indirect areas B and C, would be willing to pay more towards indirect flood protection.

The results of the Contingent Valuation give us a mean willingness to pay of $21.40 for the whole indirect benefit area of the LWWCS. Using the further classification of the indirect benefit areas, the analysis came up with a mean willingness to pay for indirect flood protection of $16.91 in indirect benefit area A, and a mean willingness to pay of $27.14 in indirect benefit areas B and C combined.

7.2 Limitations

One of the limitations of this study is that it is applicable only to the Lower Waikato area. It is not possible to extrapolate the results to fit the whole country.

An overall usable response rate of 31 percent was obtained from the survey, which is quite disappointing. Ideally it would have been better to send out more reminder letters or to have conducted personal interviews however, time and monetary constraints prevented this.

The main limitation of this study is the fact that the payment vehicle used, i.e., rates, is quite a controversial issue and many property owners in the area might have hence

declined to respond to the survey or may have understated the value of the indirect benefits to them. This may have contributed to the low response rate.

The Contingent Valuation Method has its deficiencies, however they do not invalidate the methodology. As a non-market valuation method, it is well understood that the results it yields are not perfect. "If the results of non-market valuation exercise are used as a tool for aiding decision-makers, rather than as a rule for decision making, the theoretical and practical limitations of the methods are of less concern" (Kerr, 1986). Willingness to pay estimates from such studies can at best be taken only as an indication of the level of the inclination of the public for the good or service in question.

7.3 Conclusion and Recommendations

We would rationally expect that the respondents living further away from the scheme area would be willing to pay less than those living closer to the scheme area, our results however show us the opposite. The results of the analysis indicate that the respondents further away from the floodplain i.e., indirect benefit areas B and C, were willing to pay $27.14 compared to those closer to the floodplain i.e., indirect benefit area A, having a willingness to pay of $16.91.

The reasons for this could be the fact that people in the indirect benefit area A, are more averse towards paying an increase in rates, compared to those in indirect benefit areas B and C. Out of the indirect benefit area A respondents, who were not willing to pay the offered bid, 65 percent of them believed that they already paid enough rates. Roughly the same percentage was however also indicated by the respondents not willing to pay the offered bid from indirect benefit areas B and C.

The socio-economic data that has been compiled from the survey, shows that 65.7 percent of the respondents from indirect benefit areas B and C earn more than $40,000 annually, compared to 60.7 percent of indirect benefit area A. Furthermore, 36 percent of the respondents from indirect benefit area B and C earn more than $60,000, compared to 32 percent of those from indirect area A. This indicates that a

possible reason for people in indirect benefit areas B and C willing to pay more, could be the fact that incomes are slightly higher than in indirect benefit area A.

If we assume that people in indirect benefit A, are better informed and more capable to place a value on indirect benefits from the scheme, and their estimate would be closer to the real value of the indirect benefits, then it could be that the people in indirect benefit area B and C have over-valued the indirect benefits from the LWWCS. This could possibly be due to limited information and awareness of the scheme.

This research attempted to quantify the indirect benefits from flood protection in the Lower Waikato area from the LWWCS. Such a task can prove quite difficult because of the nature of the benefits to be valued and peoples perceptions of indirect flood protection. As the people concerned in this study are not directly protected by the LWWCS, their interest in this study might be limited. This could have been one the main contributors towards the low response rate.

The credibility of the responses obtained depends very much on the reliability of the process used to obtain them. In this particular situation, to elicit values, a payment vehicle of rates and rents was used. This appeared to be the most logical and realistic vehicle for paying for the benefits from flood control. However rates are currently a controversial issue in the Waikato region (with one rate classification having recently been through court proceedings). This situation therefore was likely to increase the likelihood of protest bids or non-responses. The reason for such behaviour would be the expectation that answers were going to increase rates since indirect benefits had not been rated before.

The protest bids in the study indicated how a large number of people felt about paying rates towards indirect flood protection. One hundred and seven respondents that were not willing to pay the offered (44.4 per cent) believed that they already paid enough rates. Sixty-three of respondents not willing to pay the offered bid (26.1 per cent) wanted the Government or regional bodies to pay for the flood control scheme whereas, 53 of the respondents that were not willing to pay the offered bid (22 per cent) believed that the direct beneficiaries should bear the cost of flood protection

rather than the indirect beneficiaries. These views of the respondents should be taken in to consideration by the council when deciding on an appropriate rate to charge the beneficiaries in the area.

Despite all the shortcomings, the study can still conclude that:

- A fairly good proportion of the households in the indirect benefit areas (55.8 percent) perceives to benefit in one way or the other from the LWWCS.
- A good proportion of households in the indirect benefit areas believes that flood protection is worth paying for (65.3 percent).
- The main reasons for people not willing to pay towards indirect flood protection was the fact that they believe they already pay enough in rates (44.4 percent), and the other reason was peoples belief that the Government or regional bodies should bear the costs of the scheme (26.1 percent).
- Out of the total number of non-respondents, 19.5 percent believe that there are too many inefficiencies in the system and hence were not willing to pay.
- The most significant factors which influenced respondents' willingness to pay for indirect flood protection were, the respondents believing whether flood protection is worth paying for or not, the respondents perceiving to benefit from the LWWCS, the bid offered and the Indirect benefit area that their property falls in.
- For the indirect benefit area as a whole (A, B and C combined) an estimate of $21.40 as the mean willingness to pay seems reasonable.

This value for indirect flood protection would be $21.40 per year per household. It would be a fixed amount for each household in the indirect benefit area of the LWWCS and would not differ with the size of the property. This is because the indirect benefits from flood protection do not vary with property size. It affects the individual or household rather than the property. Property size is therefore irrelevant when concerned with indirect benefits from flood protection.

In light of these findings it may be concluded that the Contingent Valuation Method is a useful tool for indicating a willingness to pay for indirect flood protection. However, it loses some of its usefulness when applied in such a situation where the

payment vehicle is a controversial one, unless there is the time and money to test for protest bids and interview all non-respondents.

The rough magnitude of willingness to pay estimated by the technique is a reasonable one. However, in order to obtain a more accurate estimate, further research needs to be undertaken, a higher response rate has to be achieved and protest bids need to be tested.

APPENDIX 1

Relevant sections of The Resource Management Act 1991

PART II

PURPOSE AND PRINCIPLES

5. Purpose -

(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, ``sustainable management'' means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while -

(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

(b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

APPENDIX 2

Relevant sections of The Local Government Act (No.3) 1996

122F. Principles relating to funding of expenditure needs -

The principles referred to in section 122E (1) (a) of this Act (which principles are not ranked in order of priority) are -

(a) The principle that the costs of any expenditure should be recovered at the time that the benefits of that expenditure accrue:

(b) The principle that, to the extent that any expenditure - (i) Is independent of the number of persons who benefit; or (ii) Generates benefits that do not accrue to identifiable persons or groups of persons; or (iii) Generates benefits to the community generally, - the costs of that expenditure should be allocated in a manner consistent with economic efficiency and appropriate to the nature and distribution of the benefits generated, which manner may require the use of rating mechanisms under the Rating Powers Act 1988:

(c) The principle that the costs of any expenditure should be recovered from persons or categories of persons in a manner that matches the extent to which the direct benefits of that expenditure accrue to those persons or categories of persons:

(d) The principle that the costs of any expenditure to control negative effects that are contributed to by the actions or inaction of any persons or categories of persons should be allocated to those persons or categories of persons in a way that matches the extent to which they contribute to the need for that expenditure.

APPENDIX 3

Relevant sections of The Rating Powers Act 1988

41. Differential rates - (1) In adopting a differential rating system in terms of sections 79 to 93 of this Act in accordance with section 40

(3) of this Act, a Board shall take account of -

(a) The benefits that are, in the opinion of the Board, likely to accrue, directly or indirectly, to any property from the work or service in respect of which the separate rate is to be made; and

(b) The extent to which the characteristics or the use of any property, or any actions of its occupier, are, in the opinion of the Board, likely to either contribute to or alleviate the need for the work or service concerned.

(2) Where the rate is in respect of works for the protection of land from flood or erosion or for the conservation of soil or the management of water, a Board shall, for the purposes of subsection (1) of this section, give consideration to, -

(a) In relation to direct benefit, -

(i) The likelihood, frequency, depth, and severity of flooding and erosion; and

(ii) The likelihood, frequency, and extent of damage to land and the improvements to the land; and

(iii) The improvement of drainage; and

(iv) The need for water management generally, - in relation to the actual and potential uses of the land and by reference to the advantages accruing from the works concerned and the responsibility for their care and maintenance:

(b) In relation to indirect benefit, -

(i) The establishment or preservation of economic units of land; and

(ii) The protection or establishment of water, sewerage, drainage, electrical, gas, and other services and of works, services, and amenities to which rates from the land may be applied; and

(iii) The protection or establishment of communications and of any other property, service, or amenity within or benefiting the land.

Cf. 1941, No. 12, s. 102

APPENDIX 4

Survey Questionnaire

Massey University
COLLEGE OF BUSINESS

Applied and International Economics
Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 350 5799
Facsimile: 64 6 350 5660

6th August 2001

Dear Sir / Madam,

I am a postgraduate student at Massey University, undertaking research as part of my Master's thesis under the supervision of Professor Anton Meister. This research is an economic study of valuing benefits from flood protection.

In recent times increased importance has been placed on the estimation of benefits from publicly funded projects. The Rating Powers Act (1988) calls for a distribution of the costs of drainage and flood protection schemes among those who stand to benefit. This also includes people in areas not directly protected by the flood control scheme but receiving indirect benefits, such as for example, protection to road access and communication lines.

For this reason you are being asked to provide information on your perception of the value of benefits you receive from the scheme. To obtain this information any person directly involved in the management of the household / business is invited to answer the enclosed questionnaire.

According to information provided by land classifiers in the Lower Waikato Region, your property falls in the area indirectly benefiting from the Lower Waikato Waipa Flood Control Scheme (LWWCS). This means that if a major flood occurs, the LWWCS, while not directly protecing your property from flooding, would protect your road access and communication lines. These are just some of the indirect benefits provided by the scheme.

Our research is dependent upon your completion of the questionnaire, however your participation is anonymous and voluntary. Your household's views and opinions are very important for this study. We would be grateful if the questionnaire could be filled out and returned in the postage-paid envelope provided. Your response to the questionnaire will be held in complete confidence. Once the study is completed, the returned questionnaires and addresses will be destroyed.

I would be most happy to answer any questions you might have. Please write or call. The telephone number is (06) 3505799 ext 2667. Thank you in advance for your co-operation. We look forward to receiving your completed questionnaire as soon as possible.

Sincerely,

Asif Quazi
Graduate Student

Prof. Anton D. Meister
Supervisor

Te Kunenga ki Pūrehuroa
Inception to Infinity: Massey University's commitment to learning as a life-long journey

75 YEARS of innovation nga tau tuatahi

BACKGROUND

The Lower Waikato Waipa Control Scheme (LWWCS) is a comprehensive flood control scheme which provides flood protection to rural agricultural land in the Waipa and Lower Waikato valleys and provides protection to the towns of Te Kuiti, Otorohanga and Huntly. These townships and their surrounding rural areas thus receive direct benefits from the scheme. Without the LWWCS, these areas would receive most of the impacts of a major flood.

According to land classifiers, the land that your household or business occupies is not directly protected by the scheme but it does receive an **indirect benefit** based on its proximity to the scheme. If the LWWCS were not in place, then your land or property would not be directly affected in a major flood, but the surrounding areas would. This could affect your roads, telephone lines and other services causing access and communication disruption for your household or business.

People who directly benefit pay rates towards the yearly maintenance of the flood control scheme based on how much benefit they receive. Under the Rating Powers Act 1988, people who benefit indirectly are also required to pay rates towards the yearly maintenance of the scheme based on benefit received. In case of a land occupier this portion of the rates is assumed to be included in the rental or lease cost.

The main purpose of this survey is to place a value on the benefits people in the indirect benefit area receive from the flood control scheme being in place. For people like yourself who indirectly benefit from the scheme, this means valuing the protection of access to work, schools, shops, markets, hospitals, other townships, valuing the provision of an early flood warning system, the protection of the lines of communication, the more intensive or productive use of land, peace of mind and a better standard of living, among other things.

The questionnaire will take approximately 15 minutes to complete. Please tick the choices provided or fill in the short blank spaces. Please use the map provided for Question 5 and 6. The questionnaire can be returned in the freepost envelope provided. No stamp is required.

Please turn the page to begin the questionnaire

QUESTIONNAIRE

SECTION A

This section focuses on general information about people's perceptions on their reliance and use of the flood control scheme, and of the schemes direct benefit area.

1. **Please indicate how long your household has lived in the Lower Waikato Region:**

1.	Less than 1 year	[ ]
2.	1 to 10 years	[ ]
3.	11 to 20 years	[ ]
4.	21 to 30 years	[ ]
5.	31 to 40 years	[ ]
6.	41 to 50 years	[ ]
7.	Over 50 years	[ ]

2. **Please indicate which of the following describes your household / business in relation to the property you occupy:**

Owner	[ ]
Occupier	[ ]
Other	

.....

.....

3. **Have you ever experienced a flood during the time you have lived / worked in the Lower Waikato Region?**

YES / NO

4. **Before reading the letter attached at the front of this survey were you aware of the existence of the Lower Waikato Waipa Flood Control Scheme? Please circle:**

YES / NO

5. **By looking at the map provided at the back of the questionnaire, please indicate which area your property falls in:**

1.	Indirect Benefit Area A	[	]
2.	Indirect Benefit Area B	[	]
3.	Indirect Benefit Area C	[	]

6. **How often do members of your household / business visit or pass through the direct benefit areas of the LWWCS identified on the map?**

1.	Daily	[	]
2.	Weekly	[	]
3.	Monthly	[	]
4.	Yearly	[	]
5.	Never	[	]

7. **For what kind of activities does your household / business require going to or passing through the direct benefit areas?**

1.	Work	[	]
2.	School	[	]
3.	Shops	[	]
4.	Market	[	]
5.	Hospital	[	]
6.	Pub	[	]
7.	Recreation	[	]

Other please specify

.....

.....

8. **Do you believe that the LWWCS provides some level of benefit to your household / business? Please circle:**

YES / NO

9. **Has the presence of the LWWCS allowed you to change your business or use your land more intensively?**

YES / NO

If NO go to Question 11

If YES please explain:

.....

.....

.....

.....

10. **Without the LWWCS would you have made these changes?**

YES / NO

11. **If a major flood was to occur and the direct benefit areas were to receive the full effects of the flood, how would this effect your household / business and to what extent? Consider the following:**

	No Effect	Minor effect	Significant effect
• Access to work	[ ]	[ ]	[ ]
• Access to markets	[ ]	[ ]	[ ]
• Access to shops	[ ]	[ ]	[ ]
• Access to schools	[ ]	[ ]	[ ]
• Access to hospitals	[ ]	[ ]	[ ]
• Access to major townships	[ ]	[ ]	[ ]
• Communication lines	[ ]	[ ]	[ ]
• Access to recreational areas	[ ]	[ ]	[ ]
• Conservation areas	[ ]	[ ]	[ ]
• Peace of mind	[ ]	[ ]	[ ]
• Living standard	[ ]	[ ]	[ ]

Other, please specify:

.....

.....

.....

.....

.....

12. Keeping in mind the impacts of a major flood on your household (Question 11); on a scale of 0 to 5 how important is it to your household / business to avoid the following impacts:

	Not Important			Important		Very Important
Disruption of access to:						
Work	0	1	2	3	4	5
School	0	1	2	3	4	5
Shops	0	1	2	3	4	5
Markets	0	1	2	3	4	5
Hospitals	0	1	2	3	4	5
Recreational areas	0	1	2	3	4	5
Major townships	0	1	2	3	4	5
Disruption of Communication Lines	0	1	2	3	4	5
Disturbed Conservation areas	0	1	2	3	4	5
Lost Peace of Mind	0	1	2	3	4	5

SECTION B

The next few questions seek to estimate the value of indirect benefits you receive from the LWWCS. Without the scheme, you would not receive those indirect benefits. These indirect benefits, the costs saved by avoiding flood impacts, were identified by you in Questions 11 and 12. We would now like to know how much these benefits are worth to you, therefore we will ask you to either agree or disagree to pay a certain amount of money to continue to receive these benefits. Assume that, if you agree, you receive the benefits and if you decline, you will not.

13. Do you think flood protection is worth paying for?

YES / NO

If YES, continue with Question 14

If NO, please explain why:

.....

.....

.....

.....

14. Keeping in mind the importance of avoiding the negative impacts of a major flood (Question 12), would you be willing to pay an increase of $20 in yearly rates / rent, towards flood protection?

YES / NO

If YES go to Question 16

If NO continue with Question 15

15. Since you are not willing to pay the stated amount for flood protection, please indicate why?

Should be paid by Government / Regional bodies	[ ]
Direct beneficiaries should pay	[ ]
Too many inefficiencies in the system	[ ]
I already pay enough in rates / rent	[ ]
Disagree with the system	[ ]
Prefer levy on rates	[ ]
Need more information	[ ]
Cannot afford to pay	[ ]
I shouldn't pay because I do not receive any benefit	[ ]
Too much	[ ]

Other

.....

.....

.....

16. Do you have insurance that covers any of the flood contingencies listed in Question 12?

YES / NO

If YES please explain:

.....

.....

.....

.....

SECTION C

Now, I would like to ask a few questions about you, and the members of your household, to help interpret the questionnaire.

17. Please describe yourself and members of your household in terms of the following characteristics:

Household member		Male (√)	Female (√)	Age	Occupation
Yourself					
Family members in household	1				
	2				
	3				
	4				
	5				
	6				
	7				

18. Please indicate your households average annual income:

1. **Less than $10,000** [ ]
2. **$10,000 to $19,999** [ ]
3. **$20,000 to $29,999** [ ]
4. **$30,000 to $39,999** [ ]
5. **$40,000 to $49,999** [ ]
6. **$50,000 to $59,999** [ ]
7. **$60,000 and over** [ ]

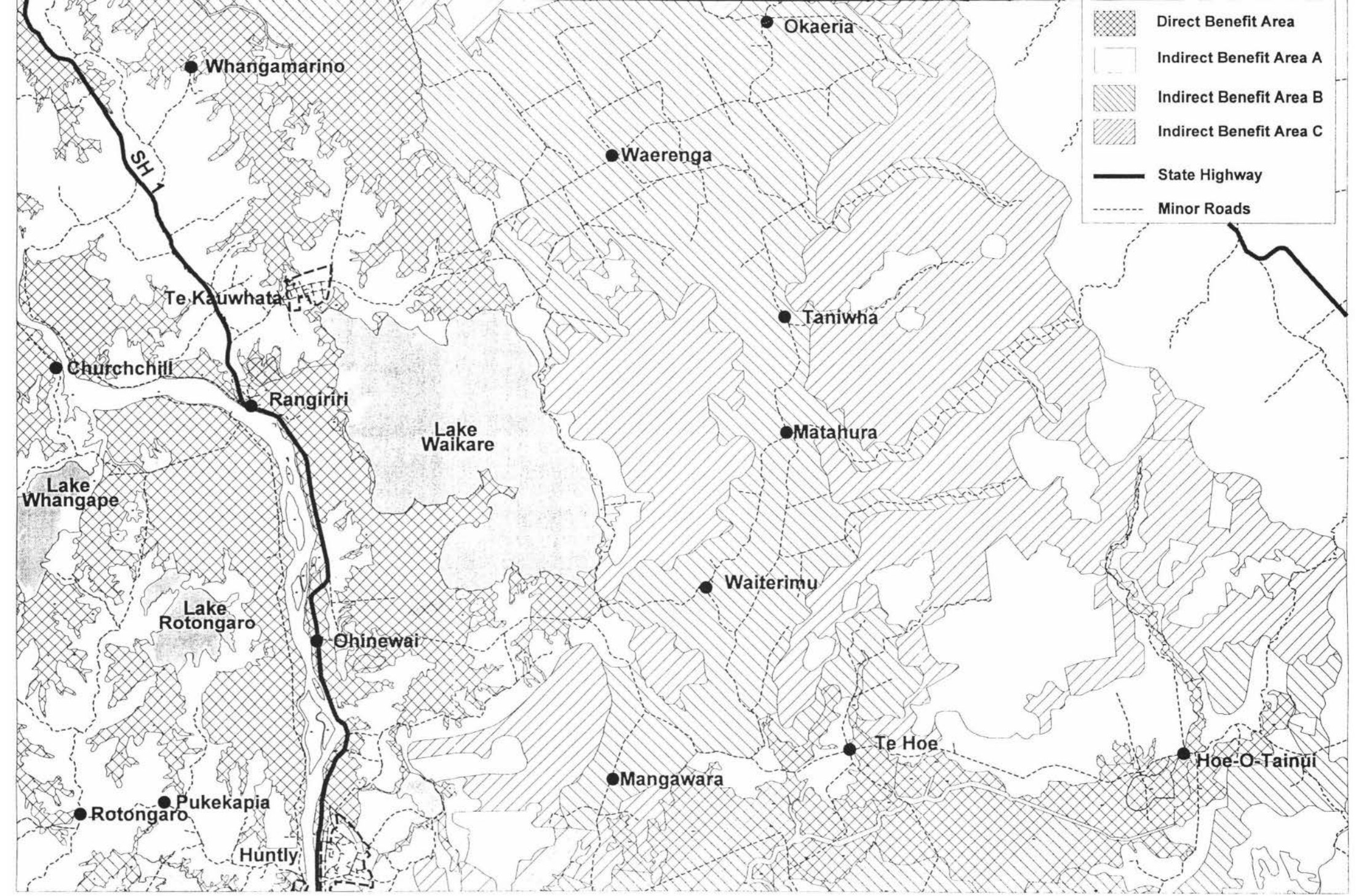
19. How many people contribute towards your household's annual income?

.....

Remember that your response to this questionnaire will be treated as strictly confidential. Your name will not be connected to any work done with your answers.

THANK YOU FOR YOUR HELP

WE ARE GRATEFUL FOR THE EFFORT YOU HAVE MADE TO COMPLETE THIS QUESTIONNAIRE. YOUR ANSWERS ARE VERY VALUABLE TO US. PLEASE RETURN YOUR QUESTIONNAIRE IN THE FREEPOST ENVELOPE PROVIDED (NO STAMP IS NEEDED).


Direct Benefit Area
Indirect Benefit Area A
Indirect Benefit Area B
Indirect Benefit Area C
State Highway
Minor Roads
Okaeria
Whangamarino
SH 1
Waerenga
Te Kauwhata
Taniwha
Churchchill
Rangiriri
Lake Waikare
Matahura
Lake Whangape
Waiterimu
Lake Rotongaro
Ohinewai
Te Hoe
Hoe-O-Tainui
Mangawara
Pukekapia
Rotongaro
Huntly

Massey University
COLLEGE OF BUSINESS

Applied and International Economics
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Palmerston North,
New Zealand
Telephone: 64 6 350 5799
Facsimile: 64 6 350 5660

27th August 2001

Dear Sir / Madam

REMINDER LETTER FOR SURVEY QUESTIONNAIRE

Approximately two weeks ago, you should have received a copy of a survey questionnaire seeking your opinion regarding flood control in the Lower Waikato. As part of the Lower Waikato region your opinion is valuable to us. This letter is to urge you to fill in the questionnaire and return it in the postage paid envelope as soon as possible.

If you have already completed and returned the questionnaire, please accept our sincere thanks. If not, please do so today. We want to be sure that the results of the questionnaire truly represent the views and values of the people in the Lower Waikato.

Thank you very much.

Sincerely,

Asif Quazi
Graduate Student

Prof. Anton D. Meister
Supervisor

Te Kunenga ki Pūrehuroa
Inception to Infinity: Massey University's commitment to learning as a life-long journey
75 YEARS of innovation and achievement

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