FINANCING CATCHMENT SCHEMES IN NEW ZEALAND

lincoln papers in water resources

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FOREWORD

Lincoln College, the College of Agriculture of the University of Canterbury, sponsors an active research and teaching programme in hydrology, soil conservation and water resources development. The purpose of these Papers is to communicate research results and new developments in these fields as rapidly as possible, and particularly to report the results of projects undertaken in conjunction by the Department of Agricultural Engineering and the New Zealand Agricultural Engineering Institute. From time to time the opportunity will be taken to publish material originating elsewhere in New Zealand with which the College is associated and which could not otherwise be made available.

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PREFACE

Volume 4 of the Lincoln Papers in Water Resources comprises the papers presented at a Training Course which was organised by the New Zealand Association of Soil Conservators and sponsored by Lincoln College. The course was held at the College on 7 to 9 May 1968, and the theme was "Financing Catchment Schemes in New Zealand."

The programme was as follows:

Tuesday 7th May

Chairman: J.R. Burton, Lincoln College.

1. Soil Conservation in New Zealand - R.D. Dick, North Canterbury Catchment Board.

2. Rivers Control and Drainage in New Zealand - N.W. Collins, Ministry of Works. S.C.R.C.C.

3. The Present Subsidy System in New Zealand - A.F. Greenall, Ministry of Works, S.C.R.C.C.

4. Financing of Soil Conservation and River Control Schemes - F.G. Howe, South Canterbury Catchment Board.

5. The Effect of Soil Conservation subsidies on Farm Development and an Example in Practice - G.A.G. Frengley, Lincoln College.

6. Workshop on systems of cost sharing and finance.

Wednesday, 8th May

Chairman: B. Douglass, Lincoln College.

7. Some Aspects of Conservation Farm Planning in the South Island. A.J. Warrington, Otago Catchment Board.

8. Farm plan, typical (Wairarapa) North Island preparation - G. Bradfield, Wairarapa Catchment Board.

9. Procedure for Preparation of Subsidy Proposals for River and Drainage Control Schemes - B.P. Dwyer, North Canterbury Catchment Board.

10. The part Treasury plays in catchment schemes - G.S. Aburn, Treasury (paper delivered by K.C. Durant, Treasury).

11. Discounting techniques - R. Jensen, Lincoln College.

12. An illustrative example of evaluation procedures - A.C. Norton, North Canterbury Catchment Board and R. Jensen, Lincoln College.

Thursday, 9th May

Chairman: A.J. Hayward, Tussock Grasslands and Mountainlands Institute.

13. Recommendations from research on persuasion for soil conservators - A.G.T. McArthur, Lincoln College.

14. Decision and scheduling plans for securing district agreement on soil conservation and river control projects - A.G.T. McArthur, Lincoln College.

15. An introduction to network analysis for soil conservators - A.G.T. McArthur, Lincoln College.

16. Integrated watershed control - J.P.C. Watt, Otago Catchment Board.

17. Co-ordination of agencies and summary of conference - D.B.Dallas, Ministry of Works, Christchurch.

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SOIL CONSERVATION IN NEW ZEALAND

R.D. Dick, M.Ag.Sc.
Chief Soil Conservator North Canterbury Catchment Board

Soil conservation has become a major influence in assisting the progress and development of New Zealand. Catchment Authorities now extend over about 70% of this country and the production of farm and run conservation plans and catchment schemes point the way to the maximum and diverse use of land according to its capabilities. Many farmers have been inspired to achieve more efficient per acre production on their properties. The acreage of soil is limited but there is no forseeable limit to the production per acre. City people receive direct and indirect benefits and widely acclaim the value of soil conservation practices.

The problems of soil erosion and the flooding of rivers have increased since European settlement. In parts of New Zealand flooding had damaged property and had been a danger to people from the initial settlement. As the population on alluvial plains increased greater efforts were made in the continual task of the construction of protective works to safeguard their land and property. Originally the then Public Works Department undertook flood control work for the purpose of protecting engineering structures such as bridges and then channel improvement to give quicker discharge of flood waters spreading over valuable land. Many local river and drainage districts had been formed in different parts of the country and Boards administering such districts, comparatively small in size and dealing with only part of a river system, found their financial reserves inadequate. Remedial works undertaken often led to increased problems in land downstream or on the other side of the river. The State was called on to assist financially a multiplicity of local authorities dealing with river control. In the 1920's and 1930's several attempts were made to improve the legislation dealing with flood control but committee reports or Bills drafted were not proceeded with. In 1937 the Public Works Department made certain recommendations to the Government but no legislation resulted. Another draft Bill was prepared in 1939 but the Government dropped it. This continued lack of decision was due to the complexity of the problem and the opposition to change by the many small local bodies. Perhaps this was fortunate because the thinking of the day was concerned largely with administrative improvements and the continuation of stopbanking and clearing river channels. People were not at that time relating soil erosion and the condition of the catchment to the downstream flood problems.

The disastrous Hawkes Bay floods occured in 1938 which caused serious slip and slump erosion in the catchments and large deposits of silt and detritus were strewn in the valley floors. There was an increased awakening of public interest. A local committee in Hawkes Bay, with D.A. Campbell as Secretary, publicised the importance of soil erosion in the river catchments and its link with the flood problems.

Ministers of the Crown were waited on and the seriousness of soil erosion in the hill country was emphasised. In the South Island the Canterbury Progress League was particularly active and well informed. The Progress League set up a special committee under the chairmanship of L.W. McCaskill who had recently returned from U.S.A. where he had been in contact with "Big Bill" Bennett. He had visited the Muskingham project in Ohio where measures were being undertaken to overcome the soil erosion and flood problems. The D.S.I.R. were taking a leading part in investigating soil erosion at this stage, e.g. D.S.I.R. Bulletin 77, 1939, presents the findings of a committee of enquiry into the "Maintenance of Vegetative Cover in New Zealand with special reference to Land Erosion", V.D. Zotov in a Survey of the Tussock Grasslands of the South Island in Bulletin 73, 1939, discusses and illustrates types of soil erosion, in 1938 N.H. Taylor wrote about "Some Aspects of Erosion of Farm Land". The result of scientific interest and the conviction of a few members of the public led the Government to set up a Select Committee - the River Control Committee which heard evidence and travelled through North Canterbury, Westland and Hawkes Bay. The Canterbury Progress League gave evidence, circulated information on Soil erosion to many local bodies, and L.W. McCaskill gave an illustrated address in Wellington to the members of Parliament. The River Control Committee which was assisted by W.L. Newnham, Engineer-in-Chief to the Public Works Department, tabled its report in 1941.

The outcome of the recommendations of this River Control Committee was the Soil Conservation and Rivers Control Act, 1941, which provided for the setting-up of the Soil Conservation and Rivers Control Council and Catchment Boards. A Bill initially conceived for the purpose of reorganising the many river and drainage Boards emerged as an Act recognising a relationship between land management and river problems. So started the present era of Soil Conservation in New Zealand.

This act established the Soil Conservation and Rivers Control Council as essentially a central administrative authority and the Catchment Authorities were to promote the objects of the Act in their respective districts. The general functions of the Council included the carrying out of surveys and investigations to ascertain the nature and extent of soil erosion, the carrying out of experiments and demonstrations in soil conservation and reclamation and the investigation and design of measures for the purpose of preventing or reducing damage by floods and the publishing of such work. One particularly important function of the Council, having regard to the objects for which the Council was established, was the co-ordinating of the policies and activities of the Government Departments, local Authorities and other public bodies.

It is now being increasingly realised how farsighted this Act was, considering the date of its enactment in 1941. This was an initial step by the Government to safeguard and utilise the land in the best interests of all the people and

protect it from unnecessary wastage. It was a logical step in the development and utilisation of the land as the numbers of people increased. Few people with ample land are not required to discipline themselves to the more exacting code of ethics necessitated by a large number of people living on a limited area of land. Such discipline is a greater challenge when many people living on a limited area of land seek a high standard of livelihood. In our time the value of adequately watered, gently sloping fertile soil is uncalcuable and unnecessary damage to land in an endeavour to seek apparent individual gain is contravening the ethics of our time.

The objects of the Act are stated briefly. The implementation of the Act is a continuing process. The design and planning of the methods to be applied to the different regions and portions of land, the implementation of schemes where one, several or many property owners are involved and the payment of the cost of such works which may include both rural and urban people are largely the responsibility of the Catchment Authorities. The planning of the possible solutions to problems including the necessary details and then fully informing the people implicated of the pros and cons of such solutions are the continuing task of Catchment Authorities. The methods of carrying out soil conservation are not written in brief words in an Act of Parliament, but are conceived in the minds of people and shaped on the anvil of science and practice. Methods are not standard throughout any one country or between one country and another. The principles of soil conservation, however, are standard within and throughout all countries.

In the Soil Conservation and Rivers Control Act neither soil conservation nor river control was confined by definition in words. This omission, if it be such, was wise. People have to learn over a period of time what the use of land and the control of water mean in their time. Any effort to spell this out in brief words for all time would be presumptuous and is likely to hinder the progressive development of a country. It is of interest to note that people who have sometimes opposed the implementation of soil conservation work have not opposed the principles involved, but rather the payment for the cost of the work or simply the dislike of change.

The rate of technological change in many of the activities of the community in the past quarter of a century has been more rapid than probably in any other period in history. Inherent in soil conservation is change. The considerable progress that has taken place in soil conservation in New Zealand is because there is the need and because there is a comparatively well educated community both on the land and in the city which is willing to face the challenge of a higher standard of ethics.

In 1945 the Council issued the Soil Conservation Regulations and these were the basis of the by-laws adopted by Catchment Authorities. The regulations and by-laws

enumerated in some detail the practices to be applied to the land as soil conservation and river control measures. They are probably the most revolutionary laws relating to rural land in the history of New Zealand in limiting the rights of individuals with land held in fee simple.

The early work of Catchment Authorities was dealing with apparent and urgent problems. This involved mostly the customary work of river protection and drainage work, but on a greater scale and with the assured maintenance of work done. The soil conservation work was new to the people. The first task was assessing the soil erosion problem and informing the public.

The Council appointed a publicity officer who later became the Government's Chief Soil Conservator. Mr. D.A. Campbell wrote a series of bulletins which the Council published that presented a dire story of soil erosion written in florid language. Dr. K.B. Cumberland, a geographer, wrote a book on Soil Erosion in New Zealand in 1945. The D.S.I.R. Bulletin by H.S. Gibbs and J.D. Raeside on Soil Erosion in the High Country of the South Island was published in 1945. There were many letters to the Press and points of view debated, sometimes quite irately. The runholders in particular, of the South Island High Country who occupied much land leased largely from the Crown were incensed at the time at such publicity. One result of the publicity of the period was that many city and rural people became aware of the words 'soil erosion' and looked at the countryside with more critical eyes than previously.

Controversy and Compromise

It was in this atmosphere that the first soil conservation officers started work with Catchment Authorities in 1946. What could be done to control soil erosion? In the South Island in the Catchment Districts when by-laws were passed all land occupiers on leasehold or freehold land, on hill and mountain country were required to get a permit from the Catchment Authority prior to "burning off" vegetation. To the Catchment Authority soil conservation staff this did not mean sitting in an office writing a general story on soil erosion to an unknown reader, but it meant getting out onto the mountain country, meeting the runholder and informing him of the injury caused to native grasslands by the customary practice of the succession of fires over the years. Discussion and debate took place and compromise reached and then followed the staff recommendations to the members of the Catchment Authority who decided upon the issuing and the conditions of the respective permits. In a few years with the understanding co-operation of runholders, the century old practice of "burning off" of steep mountain grasslands had virtually ceased. In the South Island this control of fire on the steep grazing lands of the river catchments has already been an initial major contribution in mitigating soil erosion. The result of this personal contact between land occupiers and soil conservation officers and the responsibility of the members of Catchment Authorities to

make decisions over the use of land were the first effective steps in applying soil conservation measures on the land in the South Island. In Addition, it stimulated critical thinking of the management and future use and development of the unimproved native grassland pastures.

In 1947, the D.S.I.R. published a bulletin on Soil Erosion in the Southern half of the North Island by L.I. Grange and H.S. Gibbs. Slip erosion and gullying were the obvious forms of erosion that were causing the most concern. The soil conservation officers in the North Island were introduced to these problems and with the co-operation of the land occupiers proceeded to evolve methods to overcome them.

The general interest created by the controversy on soil erosion led to further soil conservation work. More research workers became interested in field studies in botany, and plant ecology, studies in soil fertility and manurial treatments, frost studies in bare and vegetated soils, climatological work and others. Members of the Forest Service became interested in protection forests and the Forest and Range Land Institute emerged. The Tussock Grassland and Mountain Lands Institute was started. This cycle of interest and action stemmed from the ideas on soil and water conservation that were emerging in the 1940's.

In 1947 the Council sponsored the original aerial seed and topdressing experimental work which was developed and has made possible an improvement in the grassland vegetative cover, of large areas of hill and mountain land where soil erosion was a serious problem. In the South Island tussock grasslands some of the early aerial seeding was initiated in 1949 by the North Canterbury Catchment Board where some few hundred acres were seeded after an accidental fire on the Craigieburn run. The aeroplane was quickly adapted to many uses in the hill and mountain country and in a very short period of time has made possible several of the great changes that today we see in the management of these lands. Only twenty-five years ago such possibilities were hardly even dreamt of, today they are a reality.

Individual Subsidy Works

Separate subsidies works were carried out, such as gully control and wind break tree planting to prevent wind erosion of the soil and these gave experience to all concerned. The land occupiers were gaining some understanding, confidence and respect for Catchment Authorities and the members of Catchment Authorities were growing in their understanding of their responsibilities. The value of dealing with local problems by regional authorities where there are elected members and staff often living for some years in the local community, combined with national publicity from the Council in Wellington, was an effective combination in bringing about the first steps in soil conservation.

Conservation Farm and Run Plans

The next step was the preparation of conservation plans for whole properties treating the property as a unit. This was an innovation in the planning and advising on land management practices. Some people had spoken of and may have written about planning a whole property as a unit, but it was the soil conservation planning in the 1950's that successfully used this approach where soil erosion problems occurred. Conservation farm planning has got under way only since about 1955. To date almost 1,000 conservation farm plans including the Poverty Bay erosion control plans have been prepared and are operating in New Zealand. The area covered is some 3,700,000 acres of almost 9% of the land in New Zealand occupied for agricultural and pastoral purposes. In the North Island these plans are operating on a little over one million acres and in the South Island the plans cover an area of almost 2.7 million acres.

Land Inventory Surveys and Land Capability Plans

The planning is based on land inventory surveys carried out in the field and land capability plans are prepared from these data. The field surveys specify the soil type, the slope of the land, the extent and degree of erosion, the vegetation, the current land management practices and information on the altitude, aspect and climatological data. In the land capability classification there are eight classes and each class may be divided into categories. The classification is essentially based on the physical characteristics of the land and the soil erosion hazards. Up to early 1966 over 19 million acres of reconnaissance land inventory surveys have been done and over 4 million acres of detailed survey work has been completed. Thus reconnaissance surveys have covered almost 30% of New Zealand and detailed surveys have been carried out over almost 10% of the land occupied for agricultural and pastoral purposes. About $\frac{3}{4}$ of both the reconnaissance and the detailed survey work has been carried out in the South Island.

This method of classification has served soil conservation well for over two decades and many people are referring to land capability plans. Land occupiers are framing maps of the land capability plans of their properties and hanging them in a convenient place in their homes, farm advisers and State land administrators are using land capability plans and terms such as Class VIII land are widely used.

Government Soil and Water Conservation Reserves

The Council purchased several properties in the problem regions in different parts of New Zealand and proceeded to experiment with and demonstrate land management practices to prevent soil erosion and publicise soil conservation measures. This action of the Council was a bold decision at the time. The lack of sufficient suitable staff hindered progress in the early stages, but these properties continue as land on which research work and the demonstration of improved land practices are carried out.

Catchment Control Schemes

The planning of an individual property leads to the planning of several properties which comprise a unit of land - the river catchment area. This has been done in part on some catchments, but, as yet, is not a generally established practice and is the immediate challenge to the planning of soil conservation and rivers control in New Zealand. It is being attempted in two ways: - either by planning and operating a programme of work on individual properties and continuing over a period of time until all the properties within the catchment are planned, or planning the whole catchment at one time and proceeding with a comprehensive programme of work. The major difficulty lies not in the planning of the work but in meeting the cost of the work, and in getting agreement on the priorities of the different jobs by the financial contributors.

In the planning it should not be overlooked that plans differ in seeking the elusive perfection. The job of soil conservation work in New Zealand has been carried out by enthusiastic people, land occupiers, administrators, soil conservators and others. Soil conservators have had their noses to the grindstone in getting work done in time for the next monthly meeting of their employer. They have made quite an outstanding contribution in a short time as seen written on the landscape and in moulding the thinking of people. However, they have suffered from the lack of sufficient qualified men with the time to critically analyse techniques and help to overcome the difficulties that the planning and operating of conservation schemes, present. The outcome of a complete analysis of the present catchment schemes alone would help to improve local trial and error methods now being attempted.

Staff

At the end of March, 1946 there were four on the Government soil conservation staff and one Catchment Authority had appointed a soil conservation officer. The government staff were increased and approached 50 in number in the mid 1950's and there are about 30 at the present time. The Catchment Authorities were slower initially to appoint soil conservation staff but as they became confident of the value of the work more staff were appointed. Nearly all the 17 catchment authorities today employ soil conservation staff which add up to over 80. The total number on the soil conservation staff of Catchment Authorities and Government total about 110. A considerable number of the staff have been trained and have attended refresher courses at Lincoln College. The influence of the eminent teacher, L.W. McCaskill and his colleague, the late A.W. Riddolls have been a unique contribution to the progress of soil conservation in New Zealand.

Some of the Work Accomplished

The work accomplished is very diversified. Probably the greatest accomplishment is the affirmation by the people of New Zealand of the value of soil conservation work, and

the linking of land use and water control as an integrated task. Many of the pupils in secondary schools now learn something of soil conservation and teachers are anxious to get more information on the subject. The coming years will see greater emphasis placed on the teaching in our Universities of the conservation of our land and water resources. Lincoln College which started the training of soil conservation staff in this country, meanwhile seems tardy in this task, could well grasp the opportunity to provide advanced training in the theory and practice of soil and water conservation.

In the South Island the rapid reduction in the customary practice of continually burning off sizeable areas of the pastoral tussock grasslands has been a direct outcome of the work of Catchment Authorities. Following the devastations of the tussock grasslands by large numbers of rabbits and the report of the Pastoral Lands Commission of 1920, the frequency of burning the tussock grasslands in several areas had decreased, but it was the operation of Catchment Authorities in co-operation with runholders in the late 1940's and the 1950's which finally stopped the continual "burning off" of these grasslands.

The planning of soil and water conservation work has been a means of drawing together the several people with their specialist knowledge and experience. The land occupier, the soil conservator, the soil survey specialist, the forester, the farm adviser, the civil engineer, the botanist and plant ecologist, the economist, the land administrator, the hydrologist, the climatologist and the many others who are all able to offer their knowledge and experience in the formulating of plans. Comprehensive plans are the work of many. The considerable acreage already surveyed and land capability plans prepared have already been referred to.

In different parts of New Zealand about 1000 conservation run and farm plans are operating and several more are being prepared. It is only in about the last 10 years that conservation farm plans have become accepted by the farming community and great progress has been made in this time. An outcome of conservation farm planning is the increased production on these properties. Often the land occupiers operating plans are amongst the more progressive farmers in the locality and the plans help them to plan the management of their whole property in a more profitable way as well as reducing the erosion problem. All properties where there is an erosion problem are unable to get plans immediately and some may have a problem only in a particular area where a single job may be planned and subsidised. This aspect of the work should not be overlooked. In this district where we are at present, the North Canterbury District, over 110 miles of wind breaks have been planted by the farmers with the assistance of subsidy for single jobs, to reduce the wind erosion problem on light erodible soils. In the Poverty Bay and Wairarapa

districts some thousands of dams have been constructed to alleviate distinct gully problems. These works and there are many others in the different districts, indicate the value of not having too rigid an administrative system when dealing with the diversity of soil erosion problems on the land.

The visible results of soil conservation practices are being increasingly seen in the increases per acre production from properties due to the use of land according to its capabilities. There is greater diversity of production particularly by introducing or increasing beef production on the hill lands previously the preserve of sheep, the growing of trees and improved pastures, gully control and "contour" work augur well to stabilise soils and reduce detritus in the river systems. Noxious animals have been greatly reduced in many catchments and some eroded land has been retired from stock grazing and is being used for watershed protection and recreational purposes. The increasing population of New Zealand with its greater demands on the land and the implementation of the water and soil Conservation Act, 1967, are going to see even more emphasis placed on land capability planning and the application of soil conservation measures. Soil conservation work in New Zealand has really just commenced.

RIVERS CONTROL AND DRAINAGE IN NEW ZEALAND

N.W. Collins, B.E.,M.Sc.
Chief Soil Conservation and Rivers Control Engineer
Ministry of Works

I don't suppose the pre-European Maoris engaged in much river control and drainage. This would be because they had no need for this sort of work. Their life was simple and based on acceptance of nature rather than its control. The pressure of their population was not great enough to make any real demands for the management of the resources of the land. If one place became unsuitable for the needs of a Maori community, the group moved on to another place. Sometimes this gave rise to tribal warfare, which would have been a factor in controlling the rate of population growth, but this pattern of living suited them.

The advent of European settlement brought changes, slowly but inevitably. European occupation and use of land was of a much more permanent nature. The new settlers' pattern of living required the establishment of towns as well as the occupation of the land for farming. The towns were fixed and the farms were relatively fixed too. When a settler occupied land he planned to continue to occupy it as his land and to develop his use of it for his own benefit. In addition, the growth of population and the level of the use of the land, instead of resulting only from the needs and activities of the indigenous population, became controlled (and are still largely controlled) by the needs and activities of European society, particularly British society, 12000 miles away. This has involved a complicated interplay of all the forces of technology and all the forces of economics, unknown to the Maoris and practically irrelevant to the early European settlers.

A feature of European settlement was that occupation of the land spread in many cases from the lower reaches of rivers. Rivers provided the best means of communication into the hinterland. For this reason the early interest in rivers was in their use for navigation rather than in the stability of their channels or the floods they produced.

New Zealand now has a relatively highly developed and complicated society that requires all sorts of management of resources and activities - from town planning to TV licences, from the licensing of water use to research into plant and animal breeding, and including even soil conservation and rivers control and drainage. But it was not always so. Look at my particular interest of rivers control and drainage.

A hundred years ago people were too busy with other things to worry very much about constructing or trying to control rivers and, in any case, they hadn't the resources to undertake public works of this sort to any extent. They

were fully occupied with such activities as clearing and developing virgin land, establishing homes, constructing public buildings, providing essential means of communication and creating a society that would attract more settlers and continue to flourish. If a river flooded or changed its course few people were affected. If land could not be developed because it required drainage other land was used.

But gradually managing rivers and draining potential farmland became more important. Needs arose in particular localities. In the first place, no doubt, individuals tackled small works for their own benefit. There was probably some co-operation between neighbours. The provincial governments undertook public works and these would have included some isolated river works and probably some land drainage. I expect that in a few cases special local bodies were constituted to look after these needs. The central Government played a part too : in 1868 the General Assembly enacted the Canterbury Rivers Act and the Hawke's Bay and Marlborough Rivers Act. However, the main development of legislation to meet the needs of managing rivers and land drainage followed the abolition of the provinces in 1876.

What I have been trying to do is to point out that controlling rivers and draining land are not things that arise automatically from the facts that rivers exist and certain land is wet. They arise from the needs of people. And these needs are continually changing, developing and becoming more complicated. The law and the activities of government bodies are merely reflections of these social needs. And the law on matters like river control and drainage does not generally require works to be done - it merely gives authority to enable things to be done.

It will be helpful to look a little more fully at the development of the statute law in New Zealand. In 1845 the Legislative Council passed the Public Roads and Works Ordinance, the forerunner of the present Public Works Act. This ordinance did not mention rivers and land drainage or even include them by implication. The need had not then arisen. Similarly, the Municipal Corporations Ordinance of 1842 was very brief and did not authorise river works or land drainage. An Act of particular interest to Christchurch is the Christchurch District Drainage Act, passed in 1875 after the outbreak of a serious epidemic of typhoid fever. This Act established the Christchurch Drainage Board - note that it was a central Government Act, not one passed by the Provincial Government - and gave the Board very wide powers concerning watercourses, drains and sewers and defences against water. These powers were wide enough, apparently, to cover what would now be known as river control works.

Big changes were made in 1876. The provinces were abolished and replaced by counties covering the whole country.

A Public Works Act, a Counties Act and a new Municipal Corporations Act were passed. The Public Works Act 1876 dealt with land drainage but did not contain a section on rivers, although one was added when the Act was revised six years later. Both the Counties Act and the Municipal Corporations Act authorised the territorial local authorities to undertake public works as defined in the Public Works Act. It is interesting to note here that the authority of a county to undertake public works to do with rivers was made even clearer by the addition in 1956 of a clause authorising the construction of protective works to prevent damage by flood:

> The Council may construct and maintain within or outside the county any works or do anything necessary to prevent damage to any property inside the County or to the property of the Corporation outside the county from floods or erosion of rivers or streams or from encroachment of the sea.

Returning to the later years of last century we have the position where authority to manage river works and land drainage was held by the Minister of Public Works and also all the territorial local authorities. In addition there were still in force various river Acts that had been passed in early years by the General Assembly and the Provincial Governments. These early Acts had met local needs before the general system of the law had become well developed. But now, although there was authority for river and drainage works to be undertaken by the Central Government or the territorial local authorities, a new need arose : this was for special authorities on a more uniform basis to undertake these specialised types of work. The need was met legislatively by the passing of the River Boards Act in 1884, which repealed the earlier local Acts and provided for the setting up of river boards where river control problems needed attention. The first Drainage Act was passed in 1881, but this only provided for private drainage work and not for the setting up of drainage boards. However, the Land Drainage Act 1893 repealed the old Drainage Act and provided for the establishment of drainage boards to manage the public drainage of land. These enactments were early examples of the creation of ad hoc public authorities to carry out special sorts of work even though the works could have been undertaken by existing more general public authorities. It was simply a matter of recognising the advantages, in the circumstances of the time, of specialisation of work and local control of measures to meet local needs.

The legislative position remained substantially unchanged until the passing of the Soil Conservation and Rivers Control Act in 1941. This Act accomplished several important things. Firstly, it made provision for the first time for tackling soil erosion generally. Secondly, it brought together the control of soil erosion and the control of rivers and flooding under the general management of a new agency of the central Government, the Soil Conservation and Rivers Control

Council, and new ad hoc local authorities, the catchment boards. Thirdly, it not only gave the catchment boards authority to do works in the fields of river control and land drainage (although this authority was already widely held by other local bodies as well as the central Government), but it also required the catchment boards to exercise general supervision over the drainage works and river works in their districts of existing drainage boards, river boards and territorial local authorities.

The creation of yet another type of local authority able to do work in the field of rivers control and land drainage may on first consideration seem surprising; but examination of the special nature of catchment authorities shows the wisdom of the action. Foremost, the management of water in excess was brought under unified control, instead of water in rivers being regarded as one thing and water on the land being regarded as another. After all, it is all the same water, at different stages of its life. Further, it married the management of water in excess with the conservation of soil resources and the prevention of damage by erosion. This has great advantages because water in excess is the prime agent of soil erosion and because the product of soil erosion, detritus, is one of the factors making river control works necessary. In addition, the creation of catchment authorities continued the practice of specialisation - the establishment of special bodies to do special things when justified by the extent of the social demand that these things be done.

The latest legislative change was, of course, the passing of the Water and Soil Conservation Act 1967. This Act made no difference to the work of rivers control and land drainage except that it became part of something greater - a national policy in respect of natural water. The management of water in excess is now incorporated as one of the aspects of the total management of natural water.

Let us now consider the nature of rivers control and land drainage work.

What is the objective of river control work? As I indicated earlier, it is not something done for the sake of the river but a process of management to meet the needs of the people affected. The needs of the people are that loss caused to them by the river should be reduced to the to the minimum that can be economically achieved and that, again within the limit that can be economically justified the action of the river should not hinder the use they wish to make of the lands adjacent to it. I mentioned before that these needs are continually changing. They generally become greater, giving rise to a continuing demand for a greater degree of control that will effect reduced losses and provide opportunities for more intensive use of the adjacent lands. Uninformed people have often criticised river control work generally, particularly the construction of stopbanks, as a never-ending task. It has

been said, when the height of stopbanks has been increased, that this has been required because the stopbanks were constructed in the first place. This is not so. Heightening of stopbanks will almost certainly have been required because the people affected want a higher degree of protection from the river. It is only to be expected that higher degrees of protection should be continually demanded, because capital investment adjacent to rivers is continually increasing and also because, with increasing population and increasing standards of living, the pressure for the use of land is always increasing too.

In addition to the fact that the needs of the people affected change, the river itself changes too. No geographical feature is unchanging but a river has the special property that generally the bed in which it flows is composed of material that moves and breaks down into finer material. This is a natural and largely inevitable process. The flowing water moves solid particles, everything from the finest silt to huge rocks, and the impact and friction of these particles on one another, as well as weathering processes, cause attrition and the production of finer particles. Therefore, as well as the flow of water continually changing, the material of the bed of the river is also naturally undergoing continual change, at a greater or lesser rate in different rivers and different parts of each river. River control can be said broadly to consist of managing both the water and the material of the bed of the river to meet in the best way the needs of the people affected.

This dynamic property of the material of the bed of a river is a part of nature. However, the continual change that takes place can also be influenced very greatly by the results of man's activities. Apart from the increase in solids transported by a river that results from man induced erosion, to which I will refer later, there have been in New Zealand two other major activities that have changed the relationship of the water in rivers to the material of their beds. The first was gold mining, which caused the dumping into some rivers of enormous quantities of solid material. This was acceptable at the time because winning gold was more important than river engineering, but effects persist even today. The second has been the use of rivers for the generation of electricity. The effects have not been spectacular but no doubt we have not yet felt the full effect of the changes in the pattern of river flow that we have caused in the process of producing the electric power we have needed.

What particular objectives come into this management of the water and bed material of rivers? As far as the water is concerned the control of flooding is the prime objective. This control is mainly achieved by providing a channel that will contain flood flows more effectively. This may involve any of the major constructional processes of river engineering - such works as stopbanks, diversions,

dredging etc.- and also encouraging the river to improve its own channel by shifting in a useful way the movable material of its bed. Generally the more the river can be induced to do itself the better, because it is cheaper. Sometimes the flood of a river can be reduced by delaying the runoff of water or by diverting more water underground. Delay can sometimes be achieved by a detention dam or other form of temporary ponding. It is unrealistic to think that land-management practices and surface works on the land of a catchment - however desirable they may be for other reasons - can make a substantial difference to the big floods of a large river. This is because big floods result from prolonged rain over a wide area.

As far as management of the bed material is concerned the prime objective is stability of the process of movement. Both aggradation and degradation are detrimental when uncontrolled. In many New Zealand rivers the amount of material on the move has increased because of man-induced erosion in the catchment and this adds to the problems of the river engineer. This is where the soil conservator can help. Reversing a trend of increased erosion in a catchment enables a river engineer to do a better job of managing the river's channel. On the other hand the river engineer does not want all the moving solid material removed from a river - that would make the river most unnatural. Imagine, for instance, that a gigantic sieve could be installed at the lower end of the Waimakariri gorge, allowing water to pass freely but retaining all solids. In time disaster would result. Without its load of moving material the river would degrade across the plains, would erode laterally and, eventually, would lay waste hundreds of thousands of acres - unless the river engineers kept pace with the river's changes by constructing the right sort of control works, which might include a concrete channel from the gorge to the sea!

The main objectives of river control work can now be stated as follows:

1. To reduce damage by flood.

2. To reduce the area occupied by the river, whether in flood or not, so that land is not unnecessarily withheld from use.

3. To provide a channel that can be easily maintained.

4. To construct channel works and bank works that can be readily added to when a higher standard of control is warranted.

5. In all these things, to aim at a level of capital investment in river works that, at any time, is appropriate to the needs of the people - both the local people who contribute to the works as direct beneficiaries and the people of New Zealand generally

who contribute as taxpayers.

The nature and objective of land drainage work are not nearly as complicated as in the case of river control work and can be dealt with much more briefly. The objective is simply to get rid of local water on wet land so that the land can be better used. In any particular proposal there are, of course, many matters to be decided, such as:

For what rate of removal of water should the scheme be designed?

Where is the most satisfactory outfall?

What period of temporary inundation can be tolerated and how frequently?

Are pumps justified?

Can water from surrounding catchments be excluded economically?

What is the best layout of communal drains to serve all the properties involved?

What type of in-farm drainage system will the landowners wish to install?

Settling these matters is quite intricate and the result is that the design and construction of a drainage scheme are just as exacting as designing and constructing a river control scheme even though the scale of operations is generally smaller.

For land drainage works, as for river works, the appropriate level of capital investment has to be considered carefully and it has to be borne in mind that a higher standard of drainage or extension to surrounding areas may be required at some later time. It is uneconomical to drain land that is unlikely to be required for intensive use for a long time.

Land drainage work can usually be constructed more quickly than river control work - even a river control work of about the same capital cost. This is because the drainage work can generally be tackled as one continuous operation whereas a river work - like much soil conservation work - often has to be done in stages with inactive periods, between the stages of work, during which developments are awaited - such as the development of channels in a certain way, the deposition of silt in floods, or the growth of planted trees. The relatively quick construction time for communal land drainage schemes means that such work allows its benefits to be obtained quickly. However, full benefit can only be obtained if the investment in the communal work is matched by the necessary investment of capital by the individual landowner, on such items as

internal drainage, fencing, land preparation, fertilising, seeding and stocking. The rate of drainage development, therefore, often depends on the rate of capital investment justified by the progressively increasing benefits as the development proceeds.

Returning to my topic of rivers control and drainage in New Zealand, and considering present conditions rather than the history with which I began, I should like to make a few concluding remarks. I think catchment authorities have done a notably good job of their river control and land drainage work - better probably than was envisaged when the Soil Conservation and Rivers Control Act was passed in 1941. Their staff has developed special skills to suit New Zealand conditions. By the effective work accomplished they have won the confidence of the public. They have contributed substantially to our national development. Their work is by no means finished - the more they do the more is wanted of them, which is surely evidence of the success of their works. Further, I think no other authorities could have done this river control and drainage work so successfully. Before the establishment of a catchment authority it has often been said "We don't need a catchment authority. We have no special river and drainage problems"; but it is remarkable that, after a catchment authority has got to work and shown what it can do, the demands for its services are more than it can manage. The very existence of a catchment authority creates a demand or, perhaps correctly, brings to light a demand for river and drainage works that people hadn't realised they wanted and, in fact, needed for their continuing prosperity.

THE PRESENT SUBSIDY SYSTEM IN NEW ZEALAND

A.F. Greenall, M.Ag.Sc.
Chief Soil Conservator Ministry of Works

1. Introduction

The purpose of this training course is understood to be to:

(1) Record and review the position to date.

(2) Examine the application of policies, principles and procedures in practice.

(3) Consider developments or modifications which could be advantageous for future progress. The scope of this paper covers most aspects of financial assistance. Others are clearly better equipped than I to discuss river control and drainage aspects. Fortunately and understandably there is much in common between soil conservation and rivers control.

The title of this paper should be "The present system of cost-sharing". "Subsidy" is not apt. The Act provides for contribution according to benefit. Works provided for in the Soil Conservation and Rivers Control Act benefit both community and individual therefore both could be expected to contribute. Standard rates set out in Soil Conservation and Rivers Control Council circulars are ratios of benefit as between nation and individual which on experience are considered generally appropriate for the range of works used. "Cost-sharing" expresses the principle whereas "subsidy" which has a gift or charity connotation misleads. It follows that conventional loans, where the total charge for interest and redemption is met by other than the community and not in proportion to benefit derived, are not in accord with the purpose of cost-sharing. A study of sections 10, 11 and 30 of the principal Act and its amendments dealing respectively with objects, functions and finance confirms the position.

2. Statutory Authority for Cost-sharing:

Consideration of the objects and functions of Soil Conservation and Rivers Control Council, which is the agency directly responsible for authorizing funds for cost-sharing, is essential for a proper understanding of the way in which Council is bound in the discharge of its responsibility under the Act.

For those who have not a copy of the Act at hand the objects, functions and financial authority of Council are set out in section 1 of Appendix I. This is Soil Conservation and Rivers Control Council circular 1968/8 on financial assistance for measures to control soil erosion and local

flooding. There are some additional functions of Council not included in 1968/8.

3. Soil Conservation and Rivers Control Council policy in granting financial assistance:

As stated above Council has recently considered, recorded and confirmed policy on financial assistance for measures to control soil erosion and local flooding. This is set out in section 2 of the above circular which has been distributed to all Catchment Authorities and District Offices of Ministry of Works and which is available to anyone on request.

It should be emphasised that this Council circular considers only control of soil erosion and local flooding and not river control and communal drainage. There are reasons additional to those stated above for giving financial assistance for river control and communal drainage, flood and storm damage. These are as follows:

3.1 The relative inability of a community to design, promote and construct a large integrated scheme or to meet the whole cost of works which benefit the nation as well as the community.

3.2 The nation has a large equity in river control works which can best be preserved, in the case of flood damage to approved works, by financial help to quickly repair damage to those works.

3.3 Financial aid to repair any soil erosion and river control works or to land affected by flood or storm damage may be given where such help will prevent the development of a worse problem later costing more to control.

It is important to note that financial help for communal drainage is based almost entirely on benefit to increased farm production, not on soil erosion and river control, and only slightly on control of local flooding. Soil Conservation and Rivers Control Council is involved in communal drainage more because of the tie between flooding and drainage rather than because of its duty under the Act. Care is necessary to distinguish between financial help to secure the country's present investment on soil erosion and river control and to reduce the need for greater investment in future, and help on compassionate grounds because of the financial losses to individuals because of flood, storm, river and erosion damage. The latter concerns disaster relief of flood, storm and drought and is administered by government agencies other than the Soil Conservation and Rivers Control Council.

Reference to clause 2,4 of appendix I shows that financial assistance may be classified into four

headings of which Nos.1 and 4 require no further explanation.

Interest free "loans" are given where a scheme is necessary but where the local share cannot be found until later. For example a scheme was required to control local flooding and communal drainage which would convert 5,000 acres of swamp used only for limited grazing into 1 cow per acre dairy land. It was classified A on high rating per acre, which could not be met until the scheme was completed so an interest free loan was granted, repayable later. Suspensory loans are used, rarely, in cases where the ratio of benefit as between the nation and individuals cannot be readily assessed until the scheme has been completed. For example a stream improvement scheme provided for a change from low intensity pastoral use to a high intensity market garden or orchard use, but it was not possible to reliably predict that there would be a market. A suspensory loan was given which could be either written off if no market arose or repaid if one did.

4. Principles employed in applying Council's policies, for determining financial assistance:

Reference again to Appendix I section 3 shows that there are 6 main clauses governing the granting of financial assistance for control of soil erosion and local flooding.

4.1 Clause 3.1 deals with standard rates of financial assistance. These are set by Council. Those in present use are shown in Council circulars 1961/1, 1961/11 and 1964/8 and amendments.

Factors that are considered in setting rates of cost-sharing for works to control soil erosion and local flooding are:

4.1.1 Severity of erosion; e.g. 1:4 for A.T.D. & O.S. Where s light and 1:1 where severe sheet and wind erosion and depletion occurs.

4.1.2 Comprehensiveness of the plan of control; e.g. isolated works at standard rates but more strict criteria as to eligibility. Farm plans receive more favourable treatment. Catchment control schemes are given even more favoured treatment, including the same rate for conservation scheme works financed by rating as for river control works. Also special rates or works not normally assisted may be approved provided these are clearly of benefit for controlling erosion and local flooding.

4.1.3 Cost of the scheme. Where one kind of erosion costs more to control higher rates may be

given; e.g. erosion control works on gullies at 2:1 for all works including fencing, trees, dams, fascines, seed and fertilizer compared with control of slips by sowing and topdressing at 1:1. Complete schemes receive higher rates not only because they are comprehensive but because they cost more.

4.1.4 Benefit to production and revenue. Where there is no benefit to production and revenue, as in the case of a retirement fence, the full cost is met by the country compared with 2:1 for gully control where the benefit is not great, and 2:3 for conservation fencing where there is good benefit.

4.2 In general only those measures specifically approved by Council are eligible for cost-sharing. (See Appendix I Clause 3.2). About fifteen approved practices are shown in Soil Conservation and Rivers Control Council circular 1964/8. Only proved practices are included.

4.3 Clause 3.3 of Appendix I confirms that financial assistance will be given to an approved measure only where there is a significant soil erosion and flooding problem which the measure is best suited to control; e.g. stock ponds are needed particularly with cattle but also sheep on tussock grasslands mainly in semi arid regions, to assist conservation fencing in preventing stock concentration on eroded areas and to permit the use of cattle to aid re-vegetation or reduce burning.

Stock ponds are not usually needed on sown pasture lands for erosion control and are therefore not generally approved for these conditions.

A measure is usually eligible if the answer to three questions is 'Yes'.

(a) Is there a significant erosion and local flooding problem?

(b) Will the measure proposed best control the problem? (An account of the way it will effect control is desirable).

(c) Are the conditions proposed adequate to ensure the continuing control of the problem and the maintenance of the measures in good condition?

4.4 Clause 3.4 concerns the choice of alternative practices from the point of view of effectiveness, economics and practicability, e.g. gullies of ploughable land can be controlled by several practices. Where gullies are shallow and

infrequent and not dry - seed and fertilizer and grazing control is effective, practicable and not costly. Dozing might be no more effective and certainly more costly, but not in the long-term if it enables cropping and not just pastoral use. In semi arid areas such as Wither Hills, where gullies are deep and frequent in some parts and where trees will not thrive, dozing might be the only effective and practicable measure. In unploughable areas seed, fertilizer and grazing control could be the best measure in dry conditions. Trees would be equally effective and practicable but costly unless growth and location is satisfactory for timber extraction.

4.5 Many measures used for control of soil erosion and local flooding have an effect on production. This is due to the fact that these generally comprise alternative land use and management practices which also affect production. Other things being equal in respect to control of soil erosion and local flooding the measure which has the greatest influence on increasing production is to be used, e.g. a good timber tree should be grown, not a poor timber tree and the same with pastures species; subsoiling should be used rather than pasture furrows on land which suffers from extremes of wet and dry as it does not affect machine movement or sheep casting and improves soil moisture relationships and consequently production.

4.6 The Clause 3.6 of Appendix I recognises that conditions are not uniform throughout New Zealand and so there is provision for study of special cases on their merits.

5. <u>Principles applying in financial assistance for river control and communal drainage (Reference 1961/1 and 1961/11)</u>

In general the same principles apply as for soil erosion and local flooding, with some exceptions. Whereas financial assistance for control of erosion and local flooding is confined to rural areas that for river control and flooding is extended to urban lands in certain instances.

The principle is one of limited assistance in urban areas where considerable property damage and risk to life are likely, provided this is on the basis of open channel work, modest rate of cost-sharing, and where development of rural lands of more than 500 acres or half the catchment has increased the discharge of foreign rural water into the urban stormwater system; e.g. the Leith channel improvement and flood protection works in Otago (Dunedin city) where cost-sharing at 1:1 dollars was approved.

Rate of subsidy may be up to 1 dollar : 1 dollar and is based on:

(a) Cost of a reasonable standard of protection for a similar area of rural land.

(b) The magnitude of the proposed works.

(c) The financial position of the municipality.

These are clearly special cases and so economic or means tests are required just as in the special cases of assistance for control of soil erosion and local flooding. Earnest attempts on a selfhelp basis favour approval.

Much the same considerations apply to rate of and eligibility for cost-sharing of river control works as with soil erosion control works.

Works normally approved for cost-sharing are, bank protection, channel training, willow and poplar planting, plantations, lopping and layering old willows - initial treatment, willow clearing, small diversion cuts, stopbanking, channel enlargement and lagoon openings. The need to follow approved and successful district practice to provide for protection of such work and continued maintenance and in some cases to follow established specifications and codes of practice is emphasised. Provision is made to allow development of new methods. Riprap and flood damage may be assisted at a rate of 3:1. Major river control schemes may be approved at 3:1 but should there be a content of local flood control, communal drainage, etc., these could be awarded the rate normal to such works. Whereas interest free loans and suspensory loans are rare with erosion control works they are not uncommon with river works.

The rate for drainage works is 1:1 provided the proposal;

(a) benefits more than 1 property or relieves a seriously harassed property of foreign water.

(b) promotes increased farm production.

(c) provides for construction of new drains or improvements of existing watercourse not previously given government aid. Drop structures, flood gates checkdams for sub-irrigation and small pumping stations may be included.

6. Points of difference between financial assistance for different classes of Soil Conservation and Rivers Control Council works:

There are a great number of points of similarity between policy and principles covering the various classes of Council work but there are some noteworthy points of difference.

6.1 Benefit to production:

This is a key requirement of communal drainage

schemes which could in some circumstances increase erosion and flooding. It is also a requirement of river control schemes which will be approved and given priority for available funds generally only if the investment of monies can be shown to return a very good dividend.

It should also be a requirement of schemes for soil erosion control. The measure used should not only conserve soil resources and thereby affect production, but also directly of itself increase production. For example, eroded and depleted land can be reclaimed by O.S. & T.D. and grazing control. The sward will mitigate erosion and so increase future production. This sward can also be grazed and so bring about an immediate increase in stock units. As said earlier, other things being equal the most productive species should be sown without affecting eligibility of the measure for cost sharing. In practice there is unclear thinking. Some people reason that because a measure increases production it is ineligible. By the same reasoning the use of ryegrass and white clover stop banks which require grazing to keep a vigorous sward would not be eligible.

This difficulty is peculiar to those soil erosion control measures which are allied to land use and management practices used for increased production. The question should be not "are the measures productive" but, "are they standard district practice". If not they are eligible for cost-sharing if within the list of erosion control measures approved and if there is a significant problem that the measure can best control.

6.2 Maintenance of measures to control soil erosion:

There are three important features of land use and management measures most used in New Zealand for soil erosion control. The main cost to the country generally is the initial one. Provision is made for maintenance of works in perpetuity by normal farm or forest management at no cost to the country. Considerable immediate or long term increases in productivity are directly or indirectly derived from such works. This is in contrast to most other phases of Soil Conservation and Rivers Control Council work.

For these reasons there is need for a much more comprehensive and detailed study of the areas to which resources of manpower and finance could best be committed for optimum balance and best overall results. The question is "Is the present distribution between soil erosion control, river control and drainage the most beneficial?" - requires an answer.

6.3 Eligibility of urban as well as rural lands for cost-sharing:

Assistance for erosion control is confined to rural lands whereas it is extended in some cases of control of rivers and flooding to urban lands. There are many situations of erosion of urban lands which would appear similar to those where aid has been given for river and flood control.

7. Other aspects of cost-sharing:

7.1 Soil Conservation

As the name implies the function of soil conservators is soil conservation. Without doubt the soil conservation profession in New Zealand is performing this function very well according to advanced concepts, techniques and procedures which approach the best to be found throughout the world, if our authoritative overseas visitors are to be believed. However as a professional group New Zealand soil conservators need to strive for greater objectivity. This is difficult for those close to problems of people as well as land and who are concerned with the whole task of survey, design and construction to the finished job. In particular care must be taken to make sure that soil conservation is not confused with control of soil erosion and local flooding. It should always be remembered that financial assistance is given only for measures to control soil erosion and local flooding and not for the associated land use and management practices soil conservators combine with the former for full performance of their function in soil conservation.

7.2 Team work:

This function of soil conservation cannot be performed separately from the functions of other professions or agencies if the greatest benefit is to accrue to land and people. Soil Conservators have come to value working with farmers, river engineers, hydrologists and classifiers. Equally they should come to value working with farm advisory officers, foresters, economists, field officers of departments of Lands, Maori Affairs, State Advances and the like. The reverse would also apply - officers of these departments could be expected to value the worthwhile contributions soil conservators can make as members of a team. The early established procedures used by soil conservators for assessing all the qualities of land, for making predictions based thereon and for designing and executing soil erosion control schemes to achieve the objects of soil conservation within farm development programmes, are considered to be in

advance of procedures developed by their colleagues in agriculture and merit general acceptance and adoption as a worthwhile contribution to the required team approach. Soil Conservation and Rivers Control Council already requires catchment authorities to collaborate with officers of Lands Department where erosion control schemes of Crown lands are involved. Recently Council adopted recommendations made jointly by the Farm Advisory Division of Department of Agriculture and the Water and Soil Division of Ministry of Works. This is set out in Appendix II.

7.3 Greater understanding of cost-sharing needed

A conspicuous feature of cost-sharing in erosion control throughout New Zealand is the non-uniformity of interpretation. This leads to difference in treatment between areas, arguments, delays and frustations and tends to allow soil conservation to fall in disrepute. There is no room in future for the interpretation of Council's intentions on cost-sharing according to the inclinations of individuals. There is however considerable room for the exercise of good judgment, integrity and ability of the individual in determining, according to the legislative authority, policies and principles discussed, the proper level of cost-sharing appropriate to the varying circumstances encountered.

The position may be further improved should it be found possible to introduce differential rates of cost-sharing. This depends upon finding a common denominator for all types of erosion and related conditions and for standardization of L.U.C.S. procedures and criteria for objective recording together with a workable formula which would enable rates to be determined in line with these facts rather than by present rule of thumb.

Council has approved this in principle and staff have for some time been considering the problem.

7.4 General

There are three matters separate from but related to cost-sharing that should be listed, legal agreements, economic reports and classification according to benefit.

Legal agreements are required under the Act for schemes of land improvement for which financial assistance is being given to farmers. The purpose is to safeguard expenditure of public monies by prescribing conditions, the duration of the agreement, the details of work and cost and providing for maintenance of works or repayment of the amount of

financial help given, should the work be not completed satisfactorily. Registration against the title may be a necessary safeguard.

Economic reports or assessments and classification are the subject of papers by other speakers in this course but need to be considered in the context of cost-sharing.

In conclusion, I want to say that I believe much has been achieved in the field of cost-sharing by Council, Catchment Authorities and their staffs over the quarter century since the Soil Conservation and Rivers Control Act became law. There is still much to do, however.

Without doubt cost-sharing is the most controversial subject in our field of work, particularly in soil conservation.

Controversy can be wasteful and will die away only when law, policies and principles covering cost-sharing are accurately defined generally understood and accepted, and faithfully applied in practice.

This training course could and doubtless will bring about worthwhile advances in this field.

APPENDIX I

SOIL CONSERVATION AND RIVERS CONTROL COUNCIL
CIRCULAR INSTRUCTION 1968/8 4 April 1968
TO ALL CATCHMENT AUTHORITIES

FINANCIAL ASSISTANCE FOR MEASURES TO CONTROL SOIL EROSION AND LOCAL FLOODING

Council recently approved the attached principles for the granting of financial assistance for measures to control soil erosion and local flooding. These principles have, of course, been used by Council in the past for granting assistance but they have never been specifically stated before in the form now presented.

These principles are being circulated to Catchment Authorities and Ministry of Works offices so that they are aware of Council policies in this field and have a better appreciation of the reasons for giving financial assistance.

There is no restriction on the circulation by Catchment Authorities of these principles, and Authorities may consider it appropriate that a copy be given to individual land-owners with whom they have dealings in such matters.

P.G. Walker
Secretary

FINANCIAL ASSISTANCE FOR MEASURES TO CONTROL SOIL EROSION AND LOCAL FLOODING

1. Legislative Basis

1.1 Objects: The Soil Conservation and Rivers Control Council was established with the following objects - (see section 10 of the principal Act).

(a) The promotion of soil conservation:

(b) The prevention and mitigation of soil erosion:

(c) The prevention of damage by floods:

(d) The utilisation of lands in such a manner as will tend towards the attainment of the objects aforesaid.

1.2 Functions: Some of the functions of the Council relevant to soil conservation are stated in section 11 of the principal Act as follows:

(a) The carrying out of surveys and investigations to ascertain the nature and extent of soil erosion in New Zealand:

(b) The carrying out of experiments and demonstrations in soil conservation and reclamation:

(c) The investigation and design of preventive and remedial measures in respect of soil erosion:

(d) The investigation and design of measures for the purpose of preventing or reducing damage by floods or reinstating property so damaged or for the purpose of draining any land or controlling the water table in relation to any land:

(e) The recording and publishing of the results of such surveys, investigations, designs, experiments; and demonstrations:

(f) The carrying out of hydrological research, and the recording, coordinating and publishing of the results thereof:

(g) The dissemination of information with regard to soil erosion, flood control, and soil conservation and reclamation:

(h) The instruction and supervision of landholders in matters pertaining to soil conservation and reclamation:

(i) The assistance of persons whose land has been affected by soil erosion or floods or whose land may be used to fuller capacity by the control of water in relation thereto:

(j) The coordination, having regard to the objects for which the Council is established, of the policies and activities of Government Departments, local authorities, and other public bodies in relation to any of the foregoing matters and in regard to the alienation, utilisation, and occupation of lands administered, owned, or occupied by Government Departments, local authorities, or other public bodies:

(k) The general supervision and control of the activities of Catchment Boards including regular review of the economy of administration of each Board and the regular examination of surveys and investigations which may not result in the carrying out of any works.

1.3 Finance: The Council has authority to make grants or loans on such terms as it thinks fit, with the concurrence of the Minister of Finance in the case of loans to Local Authorities, from funds appropriated by Parliament for the following purposes which are set out in section 30 of the principal act.

(a) Fencing any land so as to protect vegetation thereon for the purpose of conserving the soil:

(b) Constructing defences against water and any other works for preventing the erosion of soil:

(c) Purchasing, planting, and maintaining trees, shrubs, plants, or grasses for the purpose of conserving the soil:

(d) Executing any other works or doing any other act or thing which in the opinion of the Council it is necessary or expedient to execute or do for the attainment of any of the objects for which the Council is established:

2. Council Policy in Granting Financial Assistance

Financial assistance is granted for the following main reasons:

2.1 National Interest

Conservation of soil and control of local flooding are essential in the national interest to obtain and maintain maximum production on a sustained yield basis.

2.2 Contribution According to Benefit

The principle of contribution according to benefit is contained in the Act. Measures to conserve soil and control local flooding benefit both the nation and the individual occupier of land - therefore both should contribute.

2.3 Change in Land Use

Where soil and water problems have been induced by land use and management practices, control measures generally include changes in such practices. Financial assistance is available where changes from normal district practices to one or more of the established soil and water control practices are necessary.

2.4 Methods of Granting Financial Assistance

Financial assistance is given by the Council in the following ways:

1.3.1 Grant of part of cost or cost sharing - normal cases
1.3.2 Interest free loans - special cases only
1.3.3 Suspensory loans - " " "
1.3.4 Grant of total cost - " " "

3. Principles for Determining Financial Assistance

3.1 Standard subsidy rates for financial assistance for

erosion control measures are determined by Council. The degree of financial assistance is related to the severity of erosion, the comprehensiveness of the plan of control, the beneficial effect downstream, the cost of the scheme and the benefit to production and revenue. When considering priorities for financial assistance Council gives preference to those proposals which are designed to deal adequately with the overall problems of a catchment and which confer community benefit.

3.2 Cost sharing will be restricted to those practices specifically approved by the Soil Conservation and Rivers Control Council.

3.3 Cost sharing will apply only on measures required to mitigate soil erosion and control local flooding on condition these measures are continued and maintained and used directly for control of the erosion specified.

3.4 Where different forms of control are available, the most effective, practicable and economical will be approved.

3.5 Where the differences between various forms of control are not significant, preference will be given to that control measure which will give the greatest overall benefit.

3.6 Special cases as to both type of work and the rate of financial help will be considered on their merits. Where the rate of financial help required is greater than standard, an economic analysis may be required.

APPENDIX II

SOIL CONSERVATION AND RIVERS CONTROL COUNCIL
CIRCULAR INSTRUCTION 1968/13 3 May 1968
TO ALL CATCHMENT AUTHORITIES

SOIL CONSERVATION WORKS - COOPERATION BETWEEN CATCHMENT AUTHORITIES AND FARM ADVISORY DIVISION OF THE DEPARTMENT OF AGRICULTURE

Soil Conservation and Rivers Control Council Circular 1963/6 sets out the basis for close liaison between Catchment Authorities and Government Departments, particularly with the Department of Lands and Survey on Crown Lands.

Council recently approved the attached proposal of the Directors of the Farm Advisory Division of the Department of Agriculture and Water and Soil Division of Ministry of Works, for advancing the objects of Catchment Authorities and of the two departments through greater team work of the staffs of those three bodies. Provision is made for combining control of erosion and local flooding with farm development in

balanced land improvement programmes, for resolving issues without public controversy and for establishing priorities, all of which will be beneficial to the common good. Council is sure that greater collaboration and team work by all able to contribute will benefit erosion control as well as production through providing a fuller and more effective service to farmers.

Council is aware that a team exercise in the preparation and execution of conservation farm plans is already operating in the territories of some Catchment Authorities. It requests that all Catchment Authorities adopt the policies of a team approach, not only between Soil Conservators and Field Officers of Lands Department on Crown land, but also with the Farm Advisory Officers of the Department of Agriculture, on all land requiring conservation farm plans. Council is also inviting the other agencies mentioned in the attached proposal to participate where desirable and recommends Catchment Authorities to do likewise.

This Circular is being distributed by Council to all Catchment Authorities, Ministry of Works offices and departments and agencies able to contribute.

The Farm Advisory Division of the Department of Agriculture is also sending copies of its representatives on Catchment Authorities as well as to those Farm Advisory Officers who are likely to be involved in the team approach now required.

P.G. Walker
Secretary

SOIL CONSERVATION WORKS - COOPERATION CATCHMENT AUTHORITIES & DEPARTMENTS

1. Introduction

Where plans to mitigate erosion and runoff, increase production and profitability and improve the farm enterprise as a whole are agreed on substantial benefit can accrue to the land and all concerned. This is particularly so with catchment control schemes where there is community of interest to resolve problems of erosion, drainage and flooding.

Land Use Capability Surveys in which the physical and biological qualities of the land are investigated, assessed and classified in terms of optimum use have been widely shown to be the most useful basis for design of comprehensive land improvement schemes. Benefit will therefore be derived from the greater use of such surveys.

Where soil and water problems have been induced by land use and management practices, control measures generally include changes in such practices. The changed land use and management practices proposed need to be chosen having regard not only to problems of soil and water but also to production and profit.

As this covers a wide field a team approach to design and execution of such plans, particularly involving the Catchment Authorities and the Department of Agriculture, but also several other Departments and organisations, will result in greater benefit.

2. Policy

Council from time to time formulates policies to be followed by all those involved in this work. These policies are notified by Council, together with circular instructions to all concerned in the application of these policies in practice. An exchange of policy statements and circular instructions between those involved in a team approach would be beneficial.

3. Amendment of Policy

Council does this whenever it thinks necessary, of its own volition, or after consideration of representations made by the Catchment Authorities individually or in association, or from Government Departments, or any other source.

4. Cooperation

Organisations other than Catchment Authorities may already be involved in or have information on a property proposed for a farm plan. These could include lending and advisory departments, Farm Improvement Clubs and Lincoln College Advisory Service. A management programme may be operative already.

In this case a balanced erosion control and management plan should be worked out by a team of those involved and combined in the conservation farm plan. This team approach is usually possible only if cooperation is present from the start.

Whenever there is (as well as need for a management programme) a soil erosion and water problem which merits financial assistance from Council, the cooperation required of those involved should be sought at the outset.

5. Priorities

The Council expects Catchment Authorities to establish a list of priorities, suitable for its own district, for erosion control works. Available resources must always, but particularly at the present time, be used to best advantage. Catchment Authorities are therefore to establish a list of priorities open for inspection based on severity of soil erosion and adverse hydrological conditions, with due regard to practicability and economics of control and the benefits derived from measures to control these. The prevention of erosion by the incorporation of erosion and

runoff control measures early in land development programmes is a factor in determining priorities. Catchment Authorities are to plan ahead to be in a position to commence works on the most severe and urgent problems. Other organisations involved are to encourage application to Catchment Authorities for assistance to control severe problems where these are met.

6. Integration

Good cooperation in this field of work can be achieved only if all parties are aware of each others problems and methods by which these are overcome. Personnel from all organisations involved should accordingly be encouraged to attend field days, technical conferences and courses held by each organisation. Exchange of technical publications is desirable.

FINANCING OF SOIL CONSERVATION AND RIVER CONTROL SCHEMES

F.G. Howe

The purpose of this paper is to set out the means by which soil conservation and river control schemes are financed at the present time. Although most of you will be fully aware of these facts, it is hoped that re-consideration of them will give rise to comments and suggestions for improving the financial structure.

Costs are shared by Government subsidy, and the local landholder, and the variations in subsidy rates and availability of subsidy have been referred to in another paper. Therefore, I will deal more with the local share of the cost, and the various ways of meeting it.

OUTSIDE OF RATING DISTRICTS

A lot of Catchment Authority work, which may not come within the definition of "scheme work", is done outside of special rating districts. This would apply to most "Board Work" jobs under $2000, and to soil conservation work. Fortunately, much of the latter is not isolated work but is involved with run and farm plans, which now cover a good area of our hill country, but the local share for all types of work done outside of rating districts is normally found from direct contributions by the landholders.

There is not the same financial control when the landholder is doing the work himself and claiming his subsidy later, compared to work in rating districts, and close liaison has to be maintained with landholders to ensure that a certain subsidy allocation will in fact be used in the period arranged.

If this is not done, there can be a scramble at the close of a financial year to make sure that claims are lodged and paid, because at that stage, any unused subsidy is not of much use to other divisions of an Authority's work, unless they are overspent!

The cost of adequate maintenance, particularly of river control work done outside of a rating district, can be a real problem, and although Authorities underline the need for work to be maintained, when approving a job, a lot rests with the landholder concerned. Rating districts, however small, can overcome such problems, and ensure that finance will be available when it is needed to maintain the asset created.

Maintenance, of course, is not only a matter of finance where individual jobs are concerned, but also of interest and goodwill on the part of the landholder. Many of you will know of some incredible cases where stock have been allowed to eat out planted protection works, despite the fact that the landholder paid hard cash to have the work put there, aided by subsidies.

This can happen in rating districts, too, which are more impersonal, but it is more likely to come to the staff's notice at an early date.

RATING DISTRICTS

More attention than ever is now being given to scheme planning on a whole catchment basis, but many rating districts established up to the present time cover certain areas of river or drainage where work was required.

The normal pattern, once an economic report has been prepared and sent forward to justify the fixing of subsidy rates, is for the area to be classified for rating purposes. This is done according to the degree of benefit being received, or to be received from the proposed work, whether such benefit be direct or indirect. Obviously, the landholders receiving the most benefit are placed in the highest class for rating purposes.

The procedure for classification and right of objection is carefully laid down in the Act, and it can be a time consuming matter. However, from all of this, a rating district emerges, quickly if the classification is a simple one done by agreement - but slowly if all the statutory requirements have to be followed to the letter.

During the planning of a scheme of works, rate requirements are worked out depending on whether the work will be done:

(a) out of rate revenue only, as local share, or
(b) out of loan money only, or
(c) using a combination of both.

Most of the schemes with which I have been associated have used rate revenue to finance part of the cost of the work as well as for loan repayments.

Loan money can be used only for the purpose for which it was sanctioned by the Local Authorities Loans Board, and this means that if a loan is raised for capital works only, it is not available for maintenance or repair of flood damage, so that some rate revenue must be set aside for these needs. I can think of one large rating district where delays and rising costs have meant more loans being raised than was originally intended, so that nearly all the rates are required for loan repayments. Only an increase in rates will ensure enough revenue for normal maintenance and any unexpected flood damage repairs.

If the rating district is on a whole catchment basis, rate revenue is available for soil conservation work as well as stream and river control work. In the first Opihi Catchment Control Scheme, a certain proportion of the annual rate revenue had to be allocated to soil conservation work. In most cases, the land in question was in a low classification, but rates were used to supplement local contributions from landholders for farm plan work and individual jobs. The subsidy rates varied of course, with the type of work being undertaken.

From an administrative point of view, one subsidy rate for all approved works in a catchment control scheme would be a boon.

As mentioned earlier, maintenance of work done is taken care of, in a rating district, and once the capital works are completed and loans paid off, ratepayers should find that a small maintenance rate will take care of their problems in future years.

LOAN FINANCE

At the present time, loan monies are not easy to obtain, but most major schemes of work require the use of loans in order that capital work can be completed in an efficient and economic manner. If rate revenue or local contributions are the only means of financing the local share of cost, the work must be undertaken at a more leisurely pace, which does suit some schemes such as bank protection and planting or channel clearance. However, major earthworks need to be carried out with concentrated plant and to a stage which can be safely left, and very often, loan finance enables this greater expenditure to be undertaken.

A contract for a large job often means that machines can be hired at cheaper rates than if the work is spread out over a period, so that borrowing to carry out major schemes can have its advantages.

In planning the financial details of a scheme, provision is made for raising the loan required in instalments to cover a year's expenditure at a time, and thus ease the burden of loan repayments until the capital works are well on the way to completion.

The old established idea of spreading loan repayment over 20 to 30 years still holds, but we are faced with a lender's market today, and attractive short terms often have to be offered, with the knowledge that some re-financing will be necessary in, say, 10 years' time. One of the methods in use is to borrow a sum for 10 years with repayments based on a 20 year term, and this means a renewal loan for the balance owing after the first 10 years

OTHER REVENUE

In most districts, other forms of revenue which are available for scheme works are of a minor nature, but are still a valuable supplement. I refer in particular to shingle royalties, rent from land in the rating district, and sale of timber.

(Some of these, of course, are big business in one or two areas.)

Revenue of this type does not qualify for subsidy unless approved by the Soil Conservation and Rivers Control Council beforehand. This approval is usually forthcoming for the period during which loans are being repaid, when the burden on the rating district is high, or for some other reason for economic difficulties.

ONCOST

No comments upon the financing of soil conservation and river control schemes would be complete without reference to the administrative oncost charge which Catchment Authorities have been required to collect since 1959. The legislation states "From the money that becomes available by way of local share of the cost of any work and any operation undertaken by the Board, whether the money is obtained by rating, by borrowing, or by contribution from any person or local authority, the Board shall as soon as practicable recoup to the Administrative Account the amount drawn from that account in respect of that work or operation."

It goes on to say, that such amount may be actual or estimated, or an estimated or percentage surcharge upon the average over all the Boards' operations.

In practice, Catchment Authorities use a set percentage to levy oncost on their works programmes. In our own case, this is 7½% and unlike engineering or conservation fees, oncost is not subsidised. This means that it is an added burden on the local share of any work, but it is only fair to say that many Authorities could not balance their Administrative Accounts without it.

Many remits have been put forward and suggestions made to ease the position, such as allowing the charging of oncost to be optional instead of mandatory, or that oncost should be subsidised as part of the cost of work, but no changes have been agreed upon as yet.

The effect of oncost can be quite marked where the subsidy rates are low, such as we have in some types of soil conservation work. In such cases, where the administrative content is not so high because the landholder is doing the actual work, several authorities have attempted to overcome the problem by departing from the set percentage of oncost and scaling down the charge more in line with the actual cost to the Administrative Account.

I realise that many points have been quickly passed over in these remarks, but I trust that sufficient has been said to highlight some of the problems and weaknesses in the financing of soil conservation and river control schemes at the present time.

THE EFFECT OF SOIL CONSERVATION SUBSIDIES ON FARM DEVELOPMENT AND AN EXAMPLE IN PRACTICE

G.A.G. Frengley

The term "conservation" was deliberately adopted in 1907 as the name for a popular movement in the United States.[1] Its concern was to awaken a nation to a rapidly increasing problem with its resources. The "preservation", "restoration" of resources were terms which only appeared in the literature in the late nineteenth and early twentieth century. Concern with the conservation of New Zealand's resources did not arise in any great measure until the mid 1930's. In part it is true to suggest that the inferences of the term "conservation" evoke emotionally coloured arguments rather than points of view established by fully substantiated logical reasoning. Although conservation is of direct concern to the present generation of farmers who are in a sense the custodians of our existing soil resources, other sectors of our society are also involved. Clean air societies, historic places trusts, noxious weed, pest and rabbit boards, acclimatization societies and many others including bodies concerned with water pollution are all concerned with certain aspects of the conservation of resources. An unemotional pragmatic approach must be adopted if valid conservation recommendations are to be made. The concern of the first part of this paper is to elaborate the principles for appraising alternative conservation measures.

RESOURCE CHARACTERISTICS

There are two general categories of resources; flow and stock resources. Flow resources become available over time, stock resources exist in fixed quantities. Both vary in the manner in which they can be renewed or stored. Rivers, sunshine, wind, tide are good examples of flow resources. Minerals are a traditional example of stock resources. There is however a third group of resources exhibiting characteristics of both stock and flow resources. Both biological and soil resources belong to this third group.

Tussock grasslands pastures, forests, crops, wildlife and fish are included in the group of biological resources. Biological resources are replaceable over time in the manner of a flow resource or may be exploited as a stock resource. The productivity of

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[1] Gifford Pinchot, "How Conservation Began in the United States", Agriculture History VII No.4, Oct. 1937, pp 225-265.

biological resources "may be decreased through exploitation, maintained at the present level or increased by the actions of man"[2] unlike stock and flow resources.

Soil resources combine the characteristics of stock, flow and biological resources. The stock of fertility may be exploited or destroyed, only the annual flow of fertility may be utilized, or by chemical and biological means the productive capacity of the soil may be increased.

CONSERVATION APPRAISAL

Conservation has been defined variously. An acceptable definition is that "Conservation is an investment which maintains, enhances or reduces the rate of deterioration of the potential productivity of a storable or renewable resource".[3] The concept involves orderly and efficient resource use, the elimination of waste and the maximization of social net returns over time. Thus any conservation decision calls for a deliberate choice between the present and future use of a resource. A decision can only be made by weighing the benefits of deferring the use of the resource against the costs of holding it.

The benefits are comprised of any flow of returns secured from the resource during the holding period plus the expected value of the resource when the period terminates. The value of the resource at the commencement of the period plus costs arising from improving or holding the resource must all be included in the calculation of costs. If the sum of the benefits at some future point in time exceed the sum of costs a case can be made supporting the conservation of a particular resource. If the costs exceed the benefit, no economically justifiable case can be proposed.

The introduction of time as an integral factor in the conservation of resources bring with it an additional complication. Costs and benefits occur in separate time periods. Although a positive answer to the subtraction of the cash costs from the cash benefits indicates that the scheme may be worth supporting, the answer is unsatisfactory. Money spent or income foregone in conserving a resource is an investment. Investors usually expect a defined rate of return on their investment. A positive cash answer does not indicate the worth of a project as an investment. Whether this investment is made by an individual or by a Government is immaterial. The only major difference may be the rate of return expected on their investment. Further, if an article, object, resource or an amount of cash is available to an individual or to Society now or at some future point in time both would place a higher value on the receipt of the article now than in the future. Again however, their

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[2] Arthur C. Bunce, The Economics of Soil Conservation (Ames: Iowa State College Press 1954) p.4.

[3] J.F. Timmons et al, Committee on Soil and Water Conservation Agricultural Board, National Research Council.

assessment of the value of an object received in the future may differ. Thus the expectations of society and of an individual generally differ.

The problem at hand is to relate the costs and returns assessed in different time periods. To do this, interest rate calculations have to be made. Costs must be compounded at chosen interest rates until they can be recovered. The value of income expected in the future must be discounted at the same interest rate. Unless appropriate compounding and discounting procedures are adopted, erroneous answers may be obtained for individual projects and comparisons between projects will become meaningless. Projects showing a positive cash surplus between returns and costs may have a negative value when assessed correctly in terms of their present value or present worth.

The choice of the correct interest rate to use when discounting future returns or compounding costs thus becomes a central problem in conservation appraisal. The manner in which society or an individual prefers present rather than future income can again be expressed by discount procedures. The extent to which society and individuals discount expected future returns is almost certainly different. It is most unlikely that the time preference rate for society is the average of the sum of its individual members. Indeed it would be rational to suggest that discount rates applicable to individuals are likely to be higher than those applicable to a total society, and within an individuals life time his own time preference rate may change appreciably. Apart from stating this supposition, it is beyond the scope of this paper to advance the discussion on the selection of the appropriate rate of interest.

It has now been established that resources have different characteristics; conservation involves investment over time and compounding and discounting procedures are necessary to determine the worth of such an investment. The evaluation of soil conservation practices adopted in farm development is dependent on a recognition of these facts.

The effects of adopting soil conservation measures are satisfactorily illustrated using examples taken from Barlowe.[4]

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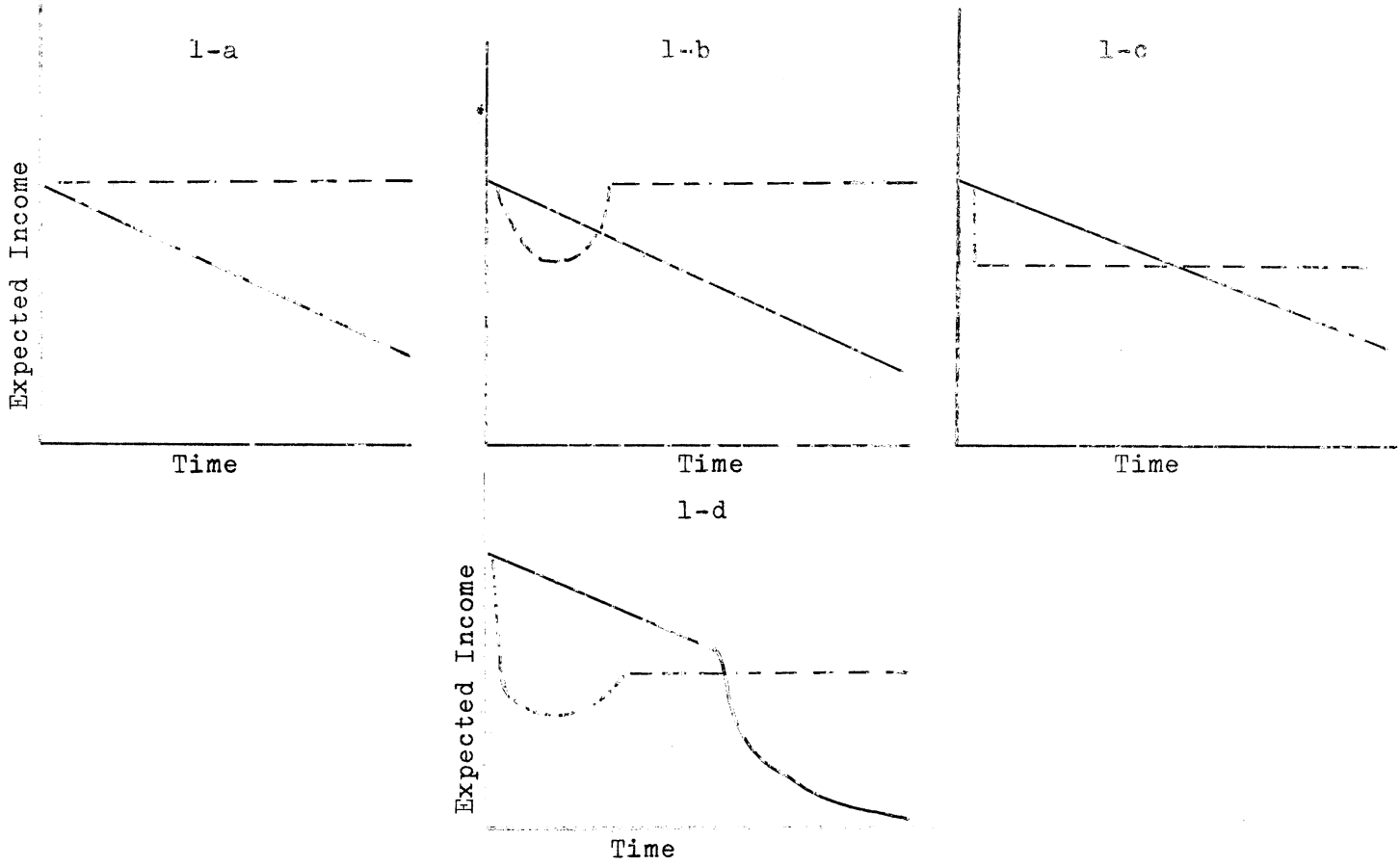
[4] Raleigh Barlowe, Land Resource Economics: The Political Economy of Rural and Urban Land Resource Use, Prentice - Hall Inc. 1958.



_____ Expected income from use of soil without conservation measures

_ _ _ _ Expected income from use of soil with conservation measures

The above cases illustrated different time patterns of conservation practices. In 1-a, the farmer is able to adopt conservation practices immediately without any loss of income. Changing from a crop rotation depleting soil fertility to a restorative programme or from overgrazing to correct pasture management illustrates the situation.

1-b illustrates the situation where an immediate sacrifice in income must be made if future income is to be maintained. The basic productive capacity of the soil has to be restored to its present level when it would otherwise continue to decline. A period of complete destocking to allow pasture recovery or the construction of structures in a watershed to prevent soil erosion, conforms with this situation.

In the third case, the farmer has two choices. Either to accept a lower income now continuing indefinitely into the future or to accept a higher income at present but continuing to decline in the future. He cannot decide later to change to a programme which will sustain the constant level of income indicated. By then

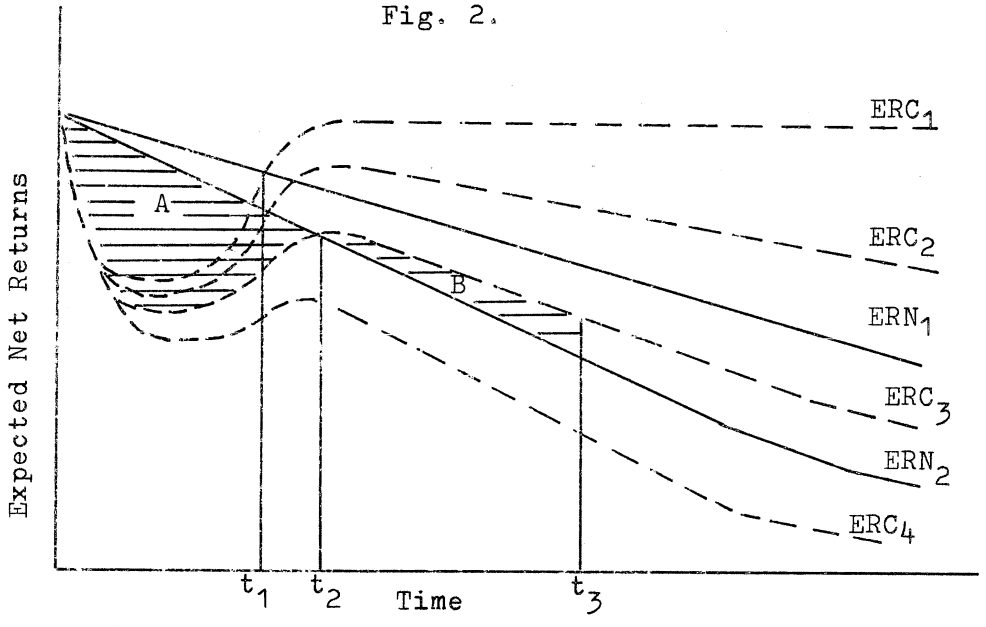
the basic productive capacity of the soil will have declined and he would have to accept a lower constant income. The situation may be exemplified by an enforced shift from mixed cropping to grassland farming or from pasture to trees. A period of overgrazing and burning may lead to permanently lower stock numbers as in many high country situations.

The last case illustrates a situation where the basic productive capacity of the soil declines constantly for a certain period. Finally, a critical situation is reached and a sudden loss occurs. The alternative is to accept conservative practices giving a lower but constant income. Cultivation practices leading eventually to wind blow, sheet erosion of shallow soils and the total loss of palatable species in a tussock grassland environment are comparable situations.

The second situation shown in section 1-b illustrates the most typical cases of investment in soil conservation. The case study described below in the latter half of this paper is an example of a conservation programme of this type.

It is wise to consider this situation in more detail.

Fig. 2.



The expected future net returns are shown above as ERN_1. They are declining continuously. The expected annual net return resulting from the adoption of the soil conservation programme are shown as ERC_1. At first, the investment in conservation results in a drop in income but this returns to its former level in a few years. At t_1 the annual returns from the conservation programme are equal to the annual returns of the soil depleting programme. From then on the difference in net cash returns between the two programmes increases. Assuming that the farmer values future income at the

same rate as income received today (zero discount rate), the adoption of the soil conservation programme will more than pay him for the temporary loss of income he has experienced.

The farmers reaction to the proposed programme may change significantly if he bases his decisions on the discounted value of his expected net returns. If the depleting and conservation programmes are both discounted at the same rate the flow of annual net returns drops to ERN_2 and ERC_2. If the planning period is long enough to allow the surplus to more than balance the loss of income the farmer will still find it profitable to accept the proposed conservation programme. If the same planning period is adopted for the undiscounted net returns (ERC_1 - ERN_1) and the discounted annual net returns (ERC_2 - ERN_2), the programme will be less rewarding when discounting procedures are applied as in the second case. This arises through discounting distant future incomes and costs more heavily than earlier returns. Proportionately, costs are increased and returns are reduced in value as benefits do not accrue unless investments have been made in earlier years. As a result conservation programmes which have a long period of investment or do not reach a break-even point for a considerable number of years may be totally unprofitable. Their outcome will be a net loss when correct discount procedures are applied. This may occur despite the fact that a conservation programme may have been assumed to have been quite profitable if the cash returns exceeded the cash costs over the total period.

If the farmer discounts the future income of the conservation programme even more heavily, and there are innumerable reasons why this could be the case, the break-even point will be delayed to t_2. The advantage of accepting the conservation programme will be reduced considerably. If the planning period is terminated at t_3, the discounted costs exceed the discounted returns. The shaded area ERC_3 - ERN_2 between t_2 and t_3 (area B in Fig.2) does not offset the loss of income ERN_2 - ERC_3 between t_0 and t_2 (area A in Fig.2). In this case he will reject the proposed conservation programme.

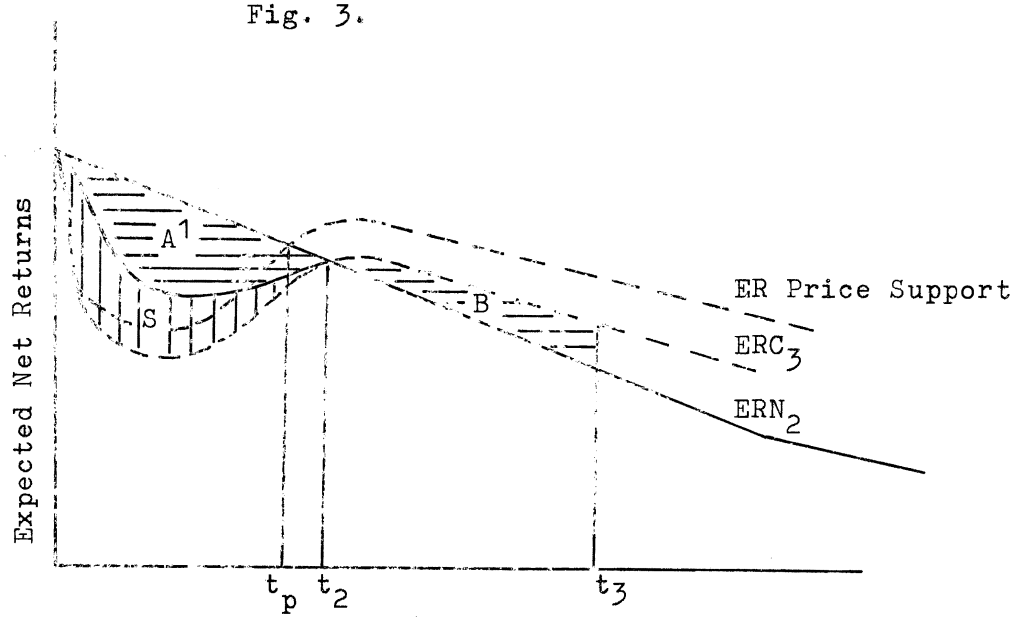
At the highest rate of preference for present rather than future income a higher ciscount rate must be used. This is represented in Fig.2 by ERC_4. The discounted expected future net returns in this case don't reach the expected returns of the programme depleting soil fertility. The acceptance of a soil conservation programme may overcome the soil depletion problem under these conditions but would merely transfer the problem from the soil resource to a financial consideration. Financial resources squandered under these conditions cannot be used elsewhere. Again we have a problem of wasted resources. It is therefore imperative to reject programmes of this type.

It is not illogical however to suggest that programmes rejected by an individual may still be worthwhile from societies point of view. If the individuals time preference rate is such that he

selects outcome ERC_3 as a result of heavily discounting future returns, he is likely to reject the proposed programme. If his planning period extends only to time t_3, in Fig.2 area A will be greater than area B and a loss would result. However, for the same programme, society as a whole may discount future returns at a lower rate. ERC_2 could be used to illustrate the outcome from the national or total society viewpoint. If the outcome is unsatisfactory for the individual but is well worthwhile nationally because of differences in discount rates, economic adjustment will be necessary to improve the outcome for the individual. The adjustment can be achieved in several ways. Fixed taxes, higher rentals and other financial alternatives can be used to force ERN_1 and hence ERN_2 to a lower level, decreasing area A and increasing area B. This is the stick in the stick and carrot act and should not be readily recommended. The adjustment can also be achieved by subsidies of two types. Price support of sufficient magnitude to increase area B to equal to area A. Alternatively, investment subsidies - cost sharing arrangements - can be used to reduce area A.

Diagrammatically this is demonstrated below.

Fig. 3.



The area represented by the area A in Fig. 2 is now divided into two parts in Fig. 3. A^1 represents the costs incurred by the farmer and S the subsidy granted in a cost sharing agreement. If the programme is to be initiated it has to become profitable to the farmer. The subsidy S must be sufficiently large to reduce A^1 until this area is smaller than B. At this stage the farmer's discounted net returns will exceed his discounted costs.

From societies point of view the net benefit of the project can be determined from Fig.2. Subtract $ERN_2 - ERC_2$ before t_1 from $ERC_2 - ERN_2$ after t_1, subject to an adjustment for taxation and interest.

If price support subsidies are adopted, the income to the farmer will be higher both during and after the development phase. The subsidies will lift ERC_3 in Fig.3 to ERP. This reduces the area A^1 + S (the cost of the project) and increases the area B. To be effective, the amount of subsidy granted must ensure that ERP - ERN_2 after time t_p is greater than ERN_2 - ERP prior to t_p.

Payment of subsidies by society to individuals is not only justified by differences in their preference for future income and hence differences in their discount rates. Subsidy payments are more commonly justified because the benefits of a programme undertaken by one man are shared by many others. This is very often the case where water erosion problems occur. The effects of fast run off and soil laden water on properties lower in a catchment are well known. Subsidies paid by farmers in a lower catchment area to others affecting conservation improvement in the upper catchment are justified providing the economic criteria can be satisfied. The discounted net returns of all those benefiting from the erosion control must exceed the discounted costs. All farmers whose production opportunities will be changed by the proposed conservation work should be included in the evaluation.

Both subsidy schemes achieve the aims outlined. They are not equally acceptable. Price support subsidies have several faults. Prices will be changing in response to normal seasonal variations and for other reasons. The manner in which the subsidy should be administered, the amount involved and the number of years over which it should be paid are all problems which may make such a scheme impossible. From the farmer's point of view there is a serious flaw with this form of subsidy. He must still find most of the liquid cash to initiate the conservation programme.

Cost sharing subsidies overcome many of the disadvantages inherent with price support subsidies. They are easier to administer, the period over which they are to be paid is finite and they help to reduce a farmers indebtedness. They are thus more acceptable to administrators and farmers alike. Investment subsidies as administered under the Act are not free from faults and some future modifications could be expected. Such proposed modifications are dependent on the outcome of current research but remain outside the scope of this paper. It is noteworthy, however, that the cost sharing approach will almost certainly remain the basis of any modified subsidy proposals.

AN EXAMPLE IN PRACTICE

General Property Description

The run is a comparatively small high country property 75 miles north of Christchurch and west of Culverden. The present area comprises:

Crown Leasehold	13,200 acres
Freehold	3.766 acres
River flats	509 acres
Total area	17,475 acres

The highest point on the leasehold block is 5,593 feet and on the freehold 3,427. The bulk of the leasehold country lies between 2,700 and 4,500 feet and the freehold between 1,200 and 2,300 feet. The homestead is at 1,200 feet above sea level. The river flats are situated seven miles from the remainder of the property and consist of Waimakariri series stony and silt phase soils.

The bulk of the property has a typical high country climate with characteristic winter snowfalls and frosts. Growth is restricted from May to October. The rainfall is 45 inches at the homestead. The river flats area has a typical mid Canterbury plains climate with low rainfall, dry summers and comparatively mild winter conditions.

Stock carried at the commencement of the run plan consisted of:

2235	half bred ewes	111	breeding cows
650	" " ewe hoggets	16	MS weaners
350	" " 2t and 4t wethers	4	AA bulls
165	wether hoggets	88	MS calves
55	rams and killers	25	Hereford heifers
Total 3455		Total 244	
Lambing % 67%		Calving 75%	

Land Capability Classes - Leasehold and Freehold area.

Class 8	Kaikoura and Tekoa steepland. Severe erosion	1912 acres
Class 7	Tekoa steepland and Kaikoura. Moderate to severe	11784 "
Class 6	Hurunui and Tekoa soils. Slight to moderate	3270 "
	Total	16968 "

The river flats consist largely of Class 3 and 4 soils of the Waimakariri series.

Production

Since 1945 the production of the leasehold has declined approx. 1% per year. The freehold has declined approx. ½% per year.

The Conservation Programme (Commenced 1963)

The objective of the programme is to improve the productivity of the Class 6 freehold hill country and approximately 400 acres of the river flats. Sufficient grazing will be provided by this development to allow the sheep grazing rights of the Class 7 and 8 land in the leasehold area to be relinquished. Cattle grazing will continue on the Class 8 area of the leasehold.

Major Features

(a) The aerial topdressing and oversowing of 1119 acres of Class 6 country to be fenced into five blocks. Over the three years following the development of these blocks, the productivity was expected to rise by 2.2 ewe equivalents to three ewe equivalents. This would therefore provide 2144 ewe equivalents of additional feed - mostly summer and early winter feed.

(b) The cultivation of approximately 200 acres of the river flats area to lucerne after turnips over a five year period. An assessed increase of 7000 lb DM per acre (4.6 ewe equivalents) was expected. This would be used mainly as hay for winter feed and totalled 920 ewe equivalents.

The total estimated increase from the development of the hill country pasture and the lucerne on the river flats was 1524 ewe equivalents.

Leasehold Grazing

At the commencement of the conservation programme in 1963 the leasehold grazing was as follows. The present position is also given.

	Ewes		Wethers		Hoggets		Cows
	1962/63	1967/68	1962/63	1967/68	1962/63	1967/68	
July	700	Nil	Nil	200	Nil	Nil	110
August	700	"	"	200	"	"	110
September	700	"	"	200	"	"	
October	700	"	"	200	"	"	
November	700	"	350	200	830	"	
December	350	"	350	1200	830	"	
January	Nil	"	350	1200	830	"	
February	2235	"	350	1200	830	"	
March	2235	"	350	1200	830	"	
April	2235	"	350	1200	830	"	
May	700	"	350	200 est	830	"	
June	700	"	350	200 est	Nil	"	
	(11,955	Nil)	(2,450	7,400)	(5,810	Nil)	
	11,955 ÷ 12		2,450 ÷ 12	7400	5,810 ÷ $\frac{2}{3}$ ÷ $\frac{1}{12}$		
	= 1000 ewe equivs		= 204	÷ 12			
				= 616	= 322		

Total 1962/63 = 1600 ee's approx (on Class 7 and 8) 1967/68 = 696 ee's

Removed = $\frac{904}{1600}$ = 56.5%

Financial Details

The total cost of the programme was estimated at approx. $21,400. The total subsidy amounted to $10,360 and the estimated cost to the farmer was $11,040. By the end of 1967 $8,800 was to have been spent.

Of the amount granted as a subsidy only 1,320 was granted for onsite soil conservation work - ridge fencing and cattle proofing. The remainder was for off-site work to allow the leasehold to be retired.

Carrying capacity of Class 7 and 8	= 1600ee's
Total cost of programme	= $20,080 off-site
	+ 1,320 on-site
	$21,400
Total cost per ee	= $13.38
Subsidy granted per ee	= $6.45

The conservation programme proposed was very satisfactory from the point of view of the cost per ewe equivalent removed from the severely eroding country.

The Actual Programme

Some changes to the original programme have been made. The first major change was made in 1966. The productivity of the property was continuing to decline up to that period and the total costs were increasing continuously. The investment required from the farmer could not readily be supported from current account expenditure. To ensure that the programme continued without undue interruption and to increase the productivity of the property at the same time, a State Advances Corporation development loan of approximately $30,000 was raised. Stock numbers have been increased considerably to 4200 sheep to be wintered and 350 cattle. At the same time the conservation programme has been advanced slightly and the rate of de-stocking is ahead of the plan.

Technically the results have been comparable with the initial expectations. The productivity of the developed area has been equal to or slightly above the forecast figures.

The rate of retirement could have been accelerated but this has been kept proportional to the amount of subsidy approved. If stock numbers had not been increased, the continuing cost/price squeeze would have forced the run holder into serious financial difficulties.

The effect on the degree of resource deterioration is difficult to determine. On the leasehold area, any animal grazing was assumed to be detrimental. Deterioration of the area is still continuing but an assumption could be made that the rate of deterioration has declined or will decline if the lagged effect is considerable. Sward regeneration is not noticeable as yet. The freehold area by contrast is improving

rapidly. The introduction of highly productive and palatable species accompanied by topdressing and adequate fencing and stocking, has lead to a very rapid build up of soil fertility and sward density. The rate of rainfall runoff has undoubtedly declined as has the loss of soil over the improved areas but there is no hydrologic data to support this contention.

It is particularly difficult to quantify the physical effects of the conservation programme up till the present time. However, the financial effects can be determined with a greater degree of precision. Conservation is an investment. Bearing this in mind it is possible to determine the outcome of the programme from societies' and the farmer's point of view. Research is currently being conducted into the profitability of this conservation programme and the results will be available shortly.

Undoubtedly what has been done in the programme to date is very satisfactory within the meaning of conservation as defined earlier - an investment which maintains, enhances or reduces the rate of deterioration of the potential productivity of a storable or renewable resource. It remains to be proven that it has been profitable.

Problems

1. The determination of "equivalent grazing" to enable the Class 7 and 8 land to be de-stocked. A unique problem arises on run country which is somewhat dissimilar to other farming situations. The summer country is grazed to enable the winter country to produce feed which is utilized from May through to late September. A considerable summer feed surplus exists from November till May or June on the winter country, sufficient to feed all stock through that period if they were removed from the summer country. The problem arises through deterioration of the quality and quantity of the feed saved to be fed-off on the winter country from May to October. The amount of feed required to enable the summer country to be de-stocked is not the sum of the ewe equivalents carried on the area over the 12 months period. Winter feed saved by utilizing summer country is subject to severe losses in feed value whereas winter feed available as high quality autumn saved pasture, forage crops and hay is not.

In the following illustration, the stock carried in each month are converted to the equivalent number of Romney ewes which would be fed for 12 months on this feed,[4] (starch equivalent basis). The ewe equivalents are then totalled for the period January to September. A calculation is then made

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4. Coop, I.E. N.Z. J.Agr.Sci. v.1 No.3 Nov.1965.

to convert these ewe equivalents to the effective winter feed requirement. This figure is the "equivalent" grazing which would be necessary to allow the summer country to be retired.[5]

Conversion of Stock Carried on Summer Country to Ewe Equivalents.

	Ewes	EE	Wethers	EE	Hogs	EE	Total
Jan.	0	0	350	19	830	41	60
Feb.	2235	91	350	19	830	41	151
March	2235	91	350	19	830	41	151
April	2235	95	350	19	830	41	155
May	700	30	350	19	830	41	90
June	700	31	-	-	-	-	31
July	700	32	-	-	-	-	32
Aug.	700	39	-	-	-		39
Sept.	700	60	-	-	-		60
Oct.	700	74	-	-	-		74
Nov.	700	80	350	19	830	41	140
Dec.	350	40	350	19	830	41	100
		663		133		287	1083

Effective amount of Winter Feed Required.

	Summer Country Ewe Equivs.	Winter feed Saved till -	Months	Expected Loss	Effective EE Required
Jan.	60	early July	6	50%	30
Feb.	151	" July	6	50%	75
March	151	July-Aug.	5	42%	88
April	155	August	4	33%	104
May	90	August	3	25%	67
June	31	August	2	17%	26
July	32	Aug.-Sept.	1	8%	29
Aug.	39	Aug.-Sept.	-	-	39
Sept.	60	September	-	-	60
Oct.	N.A.	769 EE's			518 EE's
Nov.	N.A.				
Dec.	N.A.			Saved Feed Lost =	251 EE's

Thus 518 ewe equivalents of winter feed produced by the conservation programme would be sufficient to allow the Class 7 and 8 country to be destocked. Not the 1600 ½ Bred ewe equivalents shown in the run plan (1083 Romney ewe equivalents). This is equivalent to 631 tons of lucerne hay (approx. 21,000 bales).

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5. For the basic work used to make this calculation see Coop, I.E., Dorburg, M. Anderson, C.M. The chemical composition of some tussock grassland pastures. N.Z.J.Sci.Tech. Sec.A, v.34, No.6, Ap.1953.

It is imperative that this figure should be assessed accurately as it is the basis used to determine the investment needed to complete the conservation programme. The calculations used in the run plan were made by the late Noel Holmes and the author and considering the state of knowledge at the time were satisfactory.

2. The method of allocating the subsidy: Subsidies are paid as the farmer incurs his share of the cost of development. This automatically creates a problem. Before an investment can be made, surplus funds must be available. In the farmer's case this amounts to his residual cash surplus or net cash profit after living and tax. As a result his rate of investment becomes a function of his level of production, price movements and costs. Costs will be relatively stable, but in this environment, the level of production and prices (largely wool) may vary widely. In consequence the run plan cannot be followed closely unless the farmer is prepared to borrow capital when his cash surplus is restricted.

The problem can be overcome in several ways; some are obvious. A lump sum payment of the total subsidy which has been assessed is one worthwhile alternative. This could be made at the commencement of the programme but granted in the form of a suspensory loan to be terminated after the conservation programme has been completed. If this results in an accelerated programme the outcome is likely to be more profitable to both parties. It has the added advantage of making the programme legally binding or the subsiy money is withdrawn.

There are several variations of this basic alternative, each of which has added merit. The fundamental requirements of any alternative schemes are that they should increase the potentiality and incentive for a farmer to undertake a soil conservation programme. They should be administratively simple and should not lead to the breakdown of a programme before its completion. They should also share costs equitably. Alternatives will be published at the termination of current research.

3. Fixed costs on the de-stocked area: The problem of a constant Crown rental is well known. It would be desirable for the rent to be reduced in proportion to the degree of de-stocking. The Crown's asset benefits from the retirement from grazing. If a reduction in the rate of erosion was not envisaged the programme would not have been undertaken. It would be an incentive to run holders to retire the Class 7 and 8 land and at a comparatively small cost to society.

Rabbit rates pose a more formidable problem. In the case study the rates were increased by the Board from approximately two cents to three cents per acre last year. The gross amount on the area being retired is now approximately three times greater than the rent. What is an equitable rate, and who should pay it are problems which are not yet resolved. In this particular case, Rabbit Board rates are the biggest

single fixed cost. It is imperative that recognition be given to the disincentive effect that increased fixed costs, on an unproductive asset, have on the farmer.

The above factors are the major problems. Many others exist but are of lesser importance. Time does not permit their exploration. Many of them can be readily overcome by allowing the conservation programme to be somewhat flexible. Technology and seasons are constantly changing and what may have been technically the most efficient way of affecting the programme when it was first proposed may not be at a later date. If the programme is allowed to be flexible, improvements can be readily incorporated in the programme providing they increase its profitability.

The paper has presented the theoretical background to soil conservation and its effect on farm development. Certain aspects of this have been related to the case study in the latter portion of the paper. The time restriction has not permitted a more detailed examination of the example or an elaboration of financial considerations. The publication of current research will cover all aspects of the case study not discussed in the paper.

CONCLUSIONS OF THE WORKSHOP ON SYSTEMS OF COST SHARING AND FINANCE - edited by B. Douglass

A. The present system of cost sharing through subsidy

The present system of cost sharing through the subsidy scheme is not perfect and anomalies are likely to persist. However, until such time as a better system is devised (which is unlikely in the immediate future), administrative improvement and adaption may remove unnecessary complication and facilitate the work done under the scheme.

It was suggested that the following detailed adaptions may be considered. They would reduce administrative procedures and improve the relations between the contributors of the local share and the people supervising and carrying out the work.

1. The cost sharing should cover the whole cost of jobs including

   a. work as well as materials in those jobs where materials only are subsidised.

   b. on-cost is part of the job i.e. supervision should be included in the cost sharing.

   c. the maintenance in the first year is a necessary part of construction and should be included in the cost.

2. There would be much to be gained from a simplified subsidy schedule with say only three rates applicable. This schedule may best be written on a regional basis - for example the cure of deep seated slumps in the Wairarapa is not comparable with retirement fencing in the tussock grasslands of Canterbury. A suggestion was also put forward that within regions differential subsidy rates based on severity of erosion could be worked out.

3. Several contributers suggested that if simplified schedules were established on a regional basis then further delegation of responsibility to Boards would be possible. Time consuming delays waiting for Soil Council approval would be unnecessary.

4. The workshop was unanimous that the greater use of loans either suspensory loans or low interest loans should be thoroughly investigated. They would enable farmers to initiate works without accepting the immediate financial burden of both the local and national share of the cost. The course was shown an example where refinancing (in this case through State Advances Corp) was necessary for the soil conservation programme to be continued. An analogy was drawn with the Farm Forestry Loan Scheme and it was pointed out that that scheme had some administrative advantages over the soil conservation subsidy scheme.

Technical advice was given and the correct spending of government money were ensured by that scheme with less administrative burden than the soil conservation subsidy scheme.

B. The approach to planning and financing integrated catchment schemes

The concensus of the workshop groups was difficult to define. There appeared to be no clear understanding as to what a scheme, a catchment or integration meant. There were however some evident points of agreement.

1. There is an urgent need for more detailed evaluations of financial and physical benefits of soil conservation work.

2. Until recently the approach to schemes has been piecemeal and far from integrated because of lack of understanding between disciplines. It was agreed that the team approach of all disciplines involving catchment use in all its aspects was needed and should be sought after. But, as a cautionary note, it was pointed out that single practice works must be done and there is not time to wait for complete wisdom in every case.

3. Perhaps the most difficult problem is to define and finance preventive measures rather than to find support and take action on curative ones. This is particularly evident when attempting to assess benefit derived from preventive soil conservation measures and to assess the local share of the costs.

4. It was suggested that integrated catchment schemes would be further stimulated if loan money was available at the start of the scheme. The finding of the local share at the time the works are due to start is a deterrent even when the scheme is economically attractive.

5. It was suggested that a regional planning approach would often be the best one to integrated catchment management. Whatever the approach, the administrative machinery and public relations of the body concerned can make or mar the acceptance of a scheme.

SOME ASPECTS OF CONSERVATION FARM PLANNING IN THE SOUTH ISLAND

(Based more particularly on Farm Plans prepared within the Otago Catchment Board's area)

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A. WHAT IS A CONSERVATION FARM PLAN AND HOW DOES IT DIFFER FROM OTHER EROSION CONTROL METHODS IN WHICH SUBSIDY ASSISTANCE IS INVOLVED?

A conservation farm plan is a comprehensive programme of farm development works, over a given period, which includes practices necessary to reduce soil loss by accelerated erosion and to maintain, or increase, production in safe and permanent ways.

The plans fundamental basis should be the use of the land according to its capability and limitations. This land capability classification emerges from the knowledge obtained of all the physical land characteristics, and the classification and interpretation of their combined effects on sound land use.

This information is best utilised through the "farm as a unit" approach - the conservation farm plan. In the farm plan, the soil conservation programme, based on the land's capability, should be integrated as closely as possible with the farmer's own development programme. The two together are designed not only for the purpose of conserving the soil, and preventing or repairing accelerated erosion, but also to maintain or increase production in safe, permanent ways.

Subsidies for Soil Conservation work are also made available in programmes less detailed than in farm plans. These include:

(1) Single subsidy proposals: where a single measure will control a localised erosion problem, and where no changes in management or other works are involved.

(2) Windbreak Schemes and Gully Control Schemes: specialised proposals to deal with a specific type of problem.

(3) Erosion Control Schemes: a programme of works which deals with a series of localised erosion problems (possibly of several types) on properties where large scale development, and management changes are not envisaged.

Therefore you will see that the chief distinguishing features of conservation farm plans should be the following:

(i) The comprehensive nature of the programme involved.

(ii) Changes in farm management and policies, associated with the proposed programme.

(iii) The treatment of the farm as a "whole unit" - not merely a single cure to fix a single illness.

(iv) The basic development of the proposals on the use of all land, according to its limitations and capabilities.

B. WHAT CONDITIONS ARE PECULIAR TO MUCH OF THE SOUTH ISLAND (AND TO OTAGO IN PARTICULAR IN THIS CASE) WHICH AFFECT THE PREPARATION OF FARM PLANS?

In this discussion I am considering, in particular, the tussock hill country and high country, the dry barren hills of Central Otago and some of the poorer hills and downlands lying less distant from the Coast. For it is in these areas, particularly the first three, that the bulk of conservation farm planning is necessary and is carried out.

Otago is in an unusual position in that 60% of the land is held under some form of Crown Leasehold, the majority of which is in native tussock grassland that evolved in the absence of grazing animals.

Excluding the unoccupied lands high on the western mountain ranges, there are 2.6 million acres of snow-tussock grassland and 0.4 million acres of depleted fescue tussock and scabweed country subject to significant affects of accelerated erosion.

Through a system of trial and error, the present grazing pattern of high country farming has arisen; although to an extent, grazing control was taken out of the hands of the runholder as far back as 1880 with the introduction of the rabbit. The rabbit plague alongside unwise land-use practices of excessive burning and overstocking, induced an accelerated erosion cycle.

The vast range of physical and climatic features found firstly within the Otago area, and of more importance, even within many of the properties, plays a major part in difficulties encountered in conservation farm planning in Otago. Yet at the same time, it can offer some of the best possibilities for startling and beneficial changes in farm development and better land use. Changes can occur even within a property from a semi-arid climate, with brown-grey-earth soils and supporting a stunted vegetation of scabweed, ephemeral weeds and occasional tussocks; right through the low and mid-altitude tussock zones and yellow-grey-earth and transitional

YGE/YBE soils, to dense snow tussock areas of yellow-brown-earth soils, and even to sub-alpine areas of stunted scrub, tussock, mat plants and rock, on a very impoverished and sometimes podzolised soil under a high rainfall, extremely cold temperatures and very short grazing season.

Possibly the most beneficial advantage the area enjoys, is the large proportion of the area having schist as the parent rock. A very brief reconnaissance would convince anyone of the comparative stability of this parent material when compared with greywacke, volcanic or sedimentary parent materials.

C. HOW IS THE CONSERVATION FARM PLAN PREPARED?

What basic information is required before erosion control techniques can be considered?

Initially I propose to outline briefly the steps taken in the preparation of a farm plan up to the stage of considering what different erosion control techniques and development proposals might be used:

(i) A base map is prepared, from aerial photographs, showing stream and ridge patterns, spot heights and trig stations, together with any existing improvements to the property such as fences, tracks, buildings, plantations and windbreaks.

(ii) Before field work begins, basic information on the soils, geology, and climate of the area is collected from various sources. From the soil types alone much can be learnt about a property - possible types and extent of erosion, soil fertility, and present and potential productive capacity.

(iii) A detailed Land Inventory field survey is then carried out to determine the following physical characteristics:

(a) Soil types

(b) Erosion - past and present; types and severity - measured by occurrence and soil loss.

(c) Topography - expressed as slope and measured in degrees.

(d) Present land use - expressed in terms of the vegetation present there. A measure of the depletion of this vegetation in terms of percentages of bare ground is given for native grassland area.

Areal photographs play a vital part in recording this field and topographical data. This information is then permanently recorded on Land Inventory Cards and then transferred on to the Land Inventory Map.

The Land Inventory Map then becomes one of the major bases for the assessment of the Land Capability map of the property.

This land capability map shows the classification of suitability of different areas of the property for specified long term use. It outlines limitations imposed by present and potential erosion, and the productive potentials of each area for safe maximum permanent use, based on present knowledge. Land Capability can change with the removal of limitations, or by the imposition of other limitations.

The restrictions imposed by natural physical characteristics affect:

(1) The number and complexity of the corrective practices needed.

(2) The productivity of the land.

(3) The intensity and manner of land use.

In deciding the land capability class, of any land inventory unit, the following questions should be asked:

(1) Is the land suited to the production of crops? (arable or non-arable).

(2) How much can the arable land be cultivated without producing accelerated soil loss by erosion?

(3) Is the land's safe and permanent use limited to the production of a perennial vegetation?

(4) How heaviliy can the non-arable land be grazed without causing accelerated soil erosion?

(5) Is the land best utilised alternatively for watershed protection, for supply of water for hydro-electric power, for irrigation, or for recreation?

The Land Capability Classification and system in New Zealand has been adequately covered in previous papers by Greenall, Ramsay, Howard, Dunbar, Hughes and Prickett at various times, and I shall go into no further detail on the system and its application than already given. Except to say that, if the map is to be of any lasting and worthwhile use, it must be drawn up in terms of:

(i) Broad Land Capability Classes.

then (ii) Sub-classes outlining the 5 limitations which may occur - erosion, wetness, soil limitations, climate or slope.

then (iii) Units - grouping together areas requiring the same kinds of management and treatment.

Although subjective, the classification should be soundly based on the accumulated knowledge at that time of the effects of the physical factors of the land on its best and safest long term use.

D. WHAT ARE THE DIFFERENT EROSION CONTROL METHODS WHICH MAY BE CONSIDERED IN THE FARM PLAN PROGRAMME?

Once the maps are completed, the farmer is visited again, to discuss present management of the property and future plans for development - all of which, should be considered in relation to the land capability map. The farmer usually knows the best areas of land already even if he is not fully appreciative of its land capability. The Soil Conservator outlines his ideas on conservation development works which could be undertaken. Attempts are started to integrate in the best possible way, the conservation needs of the property with the present and proposed future management.

Some of these erosion control methods (or conservation development proposals) used in the South Island, may include:

(i) Fencing for Land Retirement:
Areas of severely eroded land and depleted vegetation may be fenced and retired from stock grazing if this is considered the most practical method of controlling erosion, and promoting conservation, by natural vegetation regeneration.

(ii) Conservation Fencing:
Fencing to separate eroded areas from non-eroded summer grazing blocks from lower winter grazing blocks, and depleted sunny aspects from rank shady aspects. All these fences are considered essential for proper grazing management and for the prevention of severe vegetation depletion with consequent soil loss by accelerated erosion.

(iii) Fencing for Recuperative Spelling of land:
Seasonal spelling for reseeding, or short term retirement from stock grazing.

(iv) Cattleproofing existing fences:
Where cattle are being introduced to a property or increased in numbers, as an aid to the control of rank vegetation and bracken fern, and to help reduce excessive burning which induces erosion.

(v) A.T.D. & O.S. for "Onsite" revegetation:
The initial seeding and topdressing of severely depleted and eroded areas, subject to firm conditions of spelling, recuperative lenient grazing, and maintenance by the farmer.

(vi) A.T.D. & O.S. for the provision of equivalent "offsite" grazing:
In association with the retirement or temporary retirement of stock from an area, other areas are improved by A.T.D. & O.S. to provide extra grazing to compensate for the loss of grazing on the retired or spelled areas. Alternatives such as irrigation, drainage or cultivation and grassing, may be considered if these are as cheap as A.T.D. & O.S. to provide the "offsite" feed required.

(vii) Windbreaks:
Orientated at right angles to the prevailing winds (especially N.W.) and in areas of low rainfalls and light sandy soils. Aimed at minimising soil loss during cultivation operations, combined with rougher seed beds and cross wind drilling.

(viii) Conservation Tree Planting:

To stabilise extensively eroded faces, or control actively eroding gullies. open planting on slump faces, silt detention in gullies, and pole planting for bank erosion. Generally of far less significance than North Island practices.

(ix) Tunnel Gully Control:

Corrective and preventive work may include bulldozing in the gully and regrassing the areas; diversion banks to lead water away from the area; and possibly some open tree planting and fencing. Severely gullied areas are close planted with trees.

(x) Farm Ponds:

Used in the promotion of greater numbers of cattle, when cattle are recommended for use in rehabilitating eroded areas, or control of rank vegetation without burning.

(xi) Flood Detention Dams:

Large earth dams with controlled outlets to control stream discharges - both to reduce flooding of arable flat lands, and to prevent the spilling of silt and detritus from eroding catchments on to fertile flats.

All such proposals are covered by engineering design and report.

(xii) Strategic Firebreaks:

The construction of permanent firebreak tracks in tussock grassland areas, to divide blocks into major compartments of about 10,000 acres each. The primary purpose of these tracks is to provide quick access for preventing unauthorised and escaped fires from spreading on to steeper and higher slopes where vegetation is sparse and erosion active or imminent.

(xiii) Contour works:

Pasture furrows, contour cultivation, sub-soiling terraces and graded banks etc.

Other types of remedial measures are considered on their merits where it can be shown that they will best carry out the control and prevention of erosion for the particular area.

E WHAT ARE THE MANAGEMENT AND FINANCIAL FACTORS LIKELY TO AFFECT A FARM PLAN PROGRAMME?

Although the Conservation Farm Plan is formulated with the basic thought of reducing or preventing accelerated soil loss, the maintenance of, or increase in production must also be a governing factor in the preparation of the plan.

Various management aspects must therefore be considered when the plan is first being moulded into shape in discussion with the farmer. These include present and proposed subdivision and its effect on grazing management, condition of pastures and tussock blocks, stock types and present management, crops and winter feed

supply, water supply and shelter, and particular problems related to the area, the farm, or the farmer's own financial position and problems.

The key to Soil Conservation lies in good and prudent farm management. The major responsibility rests with the farmer. Soil Conservation is not confined only to the restoration of existing erosion. Its aim should also be to sustain maximum permanent production according to the land's capability.

Erosion is caused primarily by the misuse of the soil or the vegetation. The greater protection given to the soil, the less likelihood of erosion taking place. The better the vegetative cover maintained, the better the protection and production. Correct utilisation of pastures and particularly tussock blocks is most important, and adequate subdivision is essential to allow the satisfactory control of stock grazing pressures.

Grazing charts are a useful method of illustrating grazing patterns on extensive sheep runs, showing stock concentrations and stock movement in relation to different grazing blocks, the seeding period of native plants, and the main operations of the sheep station such as mustering, tupping, eye-clipping, dusting, shearing and weaning. Different colours are used to denote different groups of sheep. Their movements are plotted on the chart, which shows months of the year along the top and block names down the left hand edge of the page. Arrows indicate sales, transfers and movements of grazing stock.

With all this information illustrated on the chart, it can be seen at a glance which blocks are being grazed during the seeding period and with how many sheep. The carrying capacity of a block in sheep-grazing months can be estimated and a comparison of blocks of similar vegetation give an indication of excessive or light grazing pressures.

The planning officer can then return to the Land capability map for an assessment of the potential safe grazing on various blocks and compare this with present grazing pressures. He and the farmer can then determine any necessary changes and formulate a modified grazing pattern. This can be shown on a proposed grazing chart if sufficient information is available.

The objective is to relieve grazing pressures on the blocks which require spelling during the native grass reseeding period, e.g. badly depleted and eroded areas, or areas which do not respond economically to aerial oversowing and topdressing techniques. Increases in grazing pressures on the better covered blocks which at present are leniently stocked (with or without associated measures such as fencing), or provision of extra grazing by aerial oversowing and topdressing, are normally the best solutions.

In some areas, cattle may replace sheep in the less accessible valleys, or in areas of rank tussock, scrub and bracken fern vegetation, as an alternative to burning, as another source of income, and as a means of stabilising costs of management.

Thus, knowledge of types of stock, their movement and concentration, is vital to the success of any conservation development programme.

In his initial talks with the farmer, the Soil Conservator becomes familiar with the farm problems and obtains from the farmer his ideas on proposed development works. If finance is likely to be a significant problem a budget should be worked out to obtain a more accurate idea of the surplus available for a soil conservation programme. Costing of different sources of income may be necessary to decide the best product grown on the farm. A perusal of the tax return sheets as prepared by the Farm Accounting Association for example, may pinpoint some form of excessive expenditure which can be remedied. These types of financial studies can often best be done by the local Farm Economist of the Department of Agriculture. He has district information and knowledge of similar properties which can enable him to quickly assess how the farmer is doing financially. If finance is really critical, and many unfinancial farmers are on eroded properties, then Marginal Lands or State Advances development money may be available.

With all this information to hand, the Soil Conservator is ready to prepare a five year conservation farm plan.

F. CO-ORDINATION OF A "TEAM APPROACH" TO THE PREPARATION OF CONSERVATION FARM PLANS:

Because it is impossible for one man to know all the "facts about farming", the Soil Conservator must confer with and rely on the help and advice of many other people in various fields of work. The emergence of a "Team Approach" to conservation farm plans should become an exciting and conspicuous feature of this type of work. If practised with faith and willingness, it must make a significant advance to the orderly progress of providing in a truly co-ordinated manner, the best information and advice from all the various departments and agencies to the farmer. And it is the farmers problems, I might say, that is the justification for all such people being employed in their present positions in every field pertaining to Agricultural Science, and some beyond it.

These thoughts and implications have been far more soundly and fully covered previously by Greenall, Ramsay and Wilkie amongst others, and I shall let the matter, in general, rest there.

However, in a more particular way, the soil conservator, in drawing up the conservation farm plan programme with the farmer,

should also be looking for and relying on the help and advice of some, or all, of following officers and agencies:

Financial Analyses - Economists from the Department of Agriculture.

Advice on Finance for Farm Development - Marginal Lands or State Advances Corporation.

Agricultural Advisory Work - Farm Advisory Officers, Department of Agriculture.

Soils & Geology - Pedologists and Geologists of D.S.I.R.

Land Tenure and Run Management - experienced officers of the Lands and Survey Department.

Research and Trial work - officers of Research Branch of Department of Agriculture.

Stock Management - Sheep and Wool, and Livestock Instructors.

Irrigation, Drainage) - Department of Agriculture Officers,
Farm Ponds and Dams) Surveyors and Engineers.

Tree species and planting - N.Z. Forest Service and sometimes others who can give help.

When the Soil Conservator has integrated all the information into the farm plan, bearing in mind the farmers wishes and priorities, he costs the programme and works out the total cost, the subsidies involved and the annual contributions of the farmer. The runholder or farmer is then given the further opportunity to amend or accept the costed programme, because the success of the plan depends mainly upon his understanding of the plan and his enthusiasm to carry it out.

At this stage, I might say that I have found that the method which has been previously used in farm plans for indicating estimated costs, subsidy rates, subsidies and supposed farmers costs is of little use, and often even less understanding, to farmers who are interested primarily in the estimated cost of the job (or better still the actual cost) and the nett subsidy monies (or percentage) that they will receive on the completion of each job. I am pleased to see the more recent proposals in the suggested Farm Plan format circulated by the Soil Conservation & Rivers Control Council, recommending different leaflets, showing financial details in different ways, for the farmer who is interested in nett figures, and the Authority interested in gross figures prior to the removal of the various fees.

With all officers and agencies working as a team towards a common goal for the farmer, the conservation farm plan should be the most logical approach to planned farm development work. It ensures that the Government's money and the farmer's money will be used wisely in a manner compatible with correct land use based on the land's capability for the highest level of permanent production.

G. CONDITIONS COMMON TO ALL FARM PLANS AND THE SUPERVISION OF OPERATIVE FARM PLANS BY SOIL CONSERVATORS:

When both the farmer and the Soil Conservator are satisfied that the plan is practicable and financially possible, the maps and farm plan text, are finalised. The plan is then presented to the Board and Council for approval. Once given, the farmer can then proceed with the works as planned. It is his farm - not the Catchment Boards - and its success is largely up to him.

When financial assistance is given, certain restrictions must very necessarily be placed upon the recipient to protect the interests of both parties. These conditions and restrictions should have been thoroughly discussed with and made clear to the farmer. With this done, his acceptance of them and adherence to them, will be more sure and enthusiastic. Such conditions may include provisions for restrictive grazing, maintenance of subsidised works, and measures associated with subsidised items - such as provision for increase in cattle numbers, differing cultivation practices and so on.

Every farmer who adopts a Conservation Farm Plan, is required to enter into a legal agreement with the Board to carry out the works included in the plan. This agreement, which must be signed before the plan becomes operative, includes provision for the redrafting of the programme, if necessary because of financial or other reasons beyond the control of the farmer.

Once operative, a farm plan still needs and deserves and regular supervision by a Soil Conservator, and the continuing coordination of assistance from various officers of other agencies in solving the problems which always continue to arise.

Not only should soil conservators be available for the collection of details for completed works, but also to help and advise in the carrying out of the works where necessary.

With operative farm plans in Otago, we follow a system of at least quarterly contacts and reports on progress. Some of the larger properties, or more complex programmes, may require more frequent visits than this to ensure a smooth operation for the programme. Some of the smaller, more specialised programmes may not require a full quarterly visit, but rather a brief contact to see how things are going and if anything unforeseen has occurred. The quarterly reports, which are sent on to the Dunedin Office for recording purposes, cover works completed, works in progress, works not started and why, and any general comments on the state of the property. To ensure minimum confusion, each operative farm plan is placed in the care of one particular Soil Conservator who has a continuing responsibility for its oversight.

Once a year (usually about April/May) the Soil Conservator must discuss with the farmer the works programme he intends or

hopes to carry out during the following 12 months. Does he still intend to stick to the original Farm Plan programme for that year? or have some other works assumed a greater or lesser importance to the overall programme in the time that has elapsed since the programme was first drawn up? This list of intended farm plan works for the next 12 months period is then forwarded to the Dunedin office, where an overall report is drawn up to show the estimated expenditure and subsidy required for each Farm Plan property, and to request specific monetary authority for the yearly programmes from the Board, District Soil Conservator or Council, as the case may be.

Finally, the soil conservator must submit, for each operative Farm Plan under his care, an annual report on the progress of the Farm Plan programme and general improvements, development and stock numbers and performance on the property. This usually takes the form of a very much expanded quarterly report, about May or June in each year. A standard form has been prepared for use for the information required, covering stock numbers, performance, fencing, A.T.D. & O.S., cultivation, winterfeed, property improvements and changes or diversification in types of farming or stock carried.

CONCLUSION:

The systems and procedures outlined have been found to work in the situations we encounter in Otago. They seem to be acceptable to most farmers we have come in contact with. The demands for farm plan preparation, have, for several years, exceeded our ability to fulfil this demand.

With an increased amount of staff time devoted to farm plan preparation in the last 3 years or so, we now appear to be making significant inroads into the backlog of farm plan applications on hand, and it is the hope that within the next 1 or 2 years at the most, we will find ourselves in the position that we can attent to the preparation of a Farm Plan for a property within 6 to 12 months of an application by the farmer. The most curbing influence on this hope, being the ever increasing amount of staff time required to supervise operative farm plans, as the number continues to grow. To counteract this problem the Soil Conservation Staff of the Otago Catchment Board have been reclassified into a Survey and Design Section under the Farm Planning Officer and into a Service Section subdivided into 3 Divisions each under a Senior Soil Conservator responsible to the Chief Soil Conservator.

APPENDIX I:

PRESENT POSITION OF FARM PLAN PREPARATION IN THE OTAGO CATCHMENT BOARD'S AREA AS AT 31ST MARCH 1968

		Number	Area	% O.C.B. Land Area
A.	TOTAL FARM PLANS PREPARED:	91	994,910 acs.	11.70%
(1)	Operative, or Presently awaiting Council Approval.	79	928,279 acs.	10.94%
(2)	Not taken up	7	52,530 acs.	0.62%
(3)	New owner - not retaken up yet	5	8,649 acs.	0.14%
B.	WORK FOR FURTHER FARM PLANS AT VARIOUS STAGES OF PREPARATION (from Field work to programme)	21	333,680 acs.	3.96%
		6	64,240 acs.	0.76%
		(Kyeburn Catchment)		
C.	FURTHER FARM PLANS: APPLICATIONS TO HAND	15		

APPENDIX II

ACKNOWLEDGEMENTS AND REFERENCES

Acknowledgement is made to the following sources of some of the material in this paper:

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FARM PLAN

TYPICAL (WAIRARAPA) NORTH ISLAND PREPARATION

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Soil Conservator Wairarapa Catchment Board

A farm Plan is a document which sets out a physical description of a farm with its potential or limitations, probably for the first time. It contains relevant management recommendations plus details and special treatment necessary to repair or prevent erosion. The latter is accompanied with schedules of the finance required and the subsidy assistance which can be made available. Subsidy assistance is of course a powerful iducement to some, not otherwise notably conservation orientated: - Money, that scarce commodity with the ever-increasing decreasing purchasing power.

However, here is a general form of control in the Wairarapa. The farmer can approach the Board by any of the following means:

1. Written application.
2. Verbal with the Chief or the Divisional Conservator.

Either of these methods will result in an immediate visit by a member of the staff to the property to draw up a preliminary report for the Board. This report is a summary of the following:

1. Stock numbers - (Wool weight - lambing percentage)
2. Soil types
3. Erosion assessment
4. Location and area of property
5. Suitability for Farm Plan.

This information gives an idea to the Board of the capabilities of the farm in a form from which a cunning estimate can be made of the financial situation and the ability of the farmer to meet the obligations which a farm plan imposes. Once the preliminary report has been accepted work on the Plan can move ahead. However under existing conditions with most Boards, an immediate start on a new application cannot be made due to pressure of other work and a backlog of applications for plans.

Therefore to engender confidence with the farmer, a Board Work is frequently prepared for an erosion which can be controlled effectively (by Debris Dam construction cattle or retirement fencing and open or space planting). This will use the finance available from the local contribution and keep John Farmer happy for a period of one to two years. Meanwhile the Farm Plan can be prepared and the apparent time lag has disappeared as effective work is being carried out immediately.

Let us now look at the method of Farm Plan Composition.

Aerial photographs are taken and upon these are marked the land inventory boundaries, boundary fences, internal fences, stock water ponds, soil type boundaries, airstrip, house, yards etc. This takes up to two days, per 1,000 to 1,500 acres, if any of the eroding gullies are to be inspected in conjunction with preparation of the monetary estimates.

Land Capability is interpreted from the inventory mainly by slope, soil type erosions and erosion hazard and the appropriate lines drawn on the photograph parcelling the different inventory units together. A plan is now prepared of the salient features and copies made. A copy can then be taken into the field and the works required to control soil erosion in all shapes sizes and forms are marked in. On any one property this would include Retirement fencing, Close planting, Debris dams, Open stream planting, Space planting, Conservation fencing and protected block construction.

By now we have all the material available to begin to put pen to paper to describe the property and advise the farmer.

The report is set out as follows:

1. Area.
2. Location.
3. General Description.
   (a) Relief
   (b) Aspect
   (c) Precipitation and Altitude
   (d) Vegetation.
4. Soils.
   A short precise simple description aimed at enlightening the farmer with regard to fertilizer requirements and important physical characteristics.
5. Erosion types and effects.
   e.g. (a) Slump, Slip and Sheet erosion are the main forms of erosion and create the following problems.
   (i) Access disruption
   (ii) Destruction soil structure porosity and texture.
   (iii) Fertility depletion.
   (iv) Off site disruptions.

Erosion Assessment:

This is an art rather than a science and depends on where you are brought up. To exaggerate a little, leave the Canterbury Plains and Down Lands of the above and North Otago, come to the Wairarapa take one look at the hills and you begin to wonder if there is a solid place to stand. Five years later the mind is conditioned and it is hard to find severe erosion. How can this divergence of assessment be overcome?

Land Capability:

Land Capability Classification is put in the Farm Plan reports into a form which is understandable to the farmer as is seen by the following Chart.

Note: Every farmer knows his farm by the paddocks and which way they lie to the sun. Thus the set up:

Paddock Name	Total area for Paddock	Area to each class											
		II	III	IIIw	IV	IVw	VI	VIe	VIb	VII	VIIb	VIIe	VIII
Tank Hill	188	-	-	-	-	-	27	27	-	17	102	10	15
Saddle	164	-	-	-	19	-	28	-	-	-	100	-	-
Big Saddle	327	-	-	-	-	-	-	-	-	-	327	-	-
Tuckets													
Playground	10	10	-	-	-	-	-	-	-	-	-	-	-
Top flat	12	-	12	-	-	-	-	-	-	-	-	-	-
Bush flat	31	23	2	-	-	-	-	-	-	-	6	-	-
Road flat	25	17	-	-	-	-	-	-	-	-	-	-	8
Goose hill	295	-	-	4	14	11	89	-	41	19	83	-	34
Holding	9	-	-	-	-	-	9	-	-	-	-	-	-
Woolshed	21	-	-	-	-	-	21	-	-	-	-	-	-
1	4	4	-	-	-	-	-	-	-	-	-	-	-
2	8	8	-	-	-	-	-	-	-	-	-	-	-
3	5	5	-	-	-	-	-	-	-	-	-	-	-
4	8	8	-	-	-	-	-	-	-	-	-	-	-
5	10	10	-	-	-	-	-	-	-	-	-	-	-
6	31	-	-	-	-	-	-	-	-	-	28	-	3
7	21	-	-	-	14	-	6	-	-	1	-	-	-
8	45	-	-	-	-	-	-	-	39	-	-	-	6
9	22	22	-	-	-	-	-	-	-	-	-	-	-
Total Acres	1,236	107	14	4	47	11	180	27	80	37	646	10	73
Percentage	100	8.6	1.1	0.3	3.8	0.9	14.5	2.1	6.5	3.0	52.5	0.8	5.9

After the farmer has perused this with the map along side him he has an idea what we are talking about. Following under this summary is a description of each class of land again in a form to enlighten the farmer. e.g.

Class IV Land - 47 acres - 3.8% of farm.

This land has severe limits to arable use and the choice of crops which can be grown. The main impediment in this case is climatic as the land is on the wide ridge tops which are extremely exposed and the soil has a poor moisture holding capacity. Thus after a primary cultivation to introduce better grass species, this class of land should be left for a long period under pasture.

After a similar description of each class with the important features of the class in each case pointed out a summary of the units of production are recorded.

Production Notes

e.g. Area of property = 1,664 acres.

Sheep Ewe equivalents per acre	= 2.65
Cattle " " " "	= 1.31
Total " " " "	= 3.96
Total wool Weight	= 58,800 lbs or 35.1 lbs/ac
Wool per sheep Ewe equivalent	= 13.25 lbs.
Lambing %	= 96
Unit production assessment	= 532

Hard on the heals of the above follows a paddock by paddock description setting out physical details of the paddock together with management recommendations and details of any special conservation measures required and cost estimates where subsidy is involved.

A typical description of a paddock would be:

Paddock 4 - 411 acres (Total area of farm 1,775 acres).

Dissection is very heavy on the southerly face of this paddock with the added problem of severe slumping, the cause of which is the rapid down cutting of the main creek which divides the paddock in half. Stream degrade is still occuring, but it would appear to be at a slower rate as many of the slumps have healed over at the toe and regained stability. On the North aspect wind keeps the eroded faces continually bare dessicating any vegetation which tries to colonize the exposed sub soil.

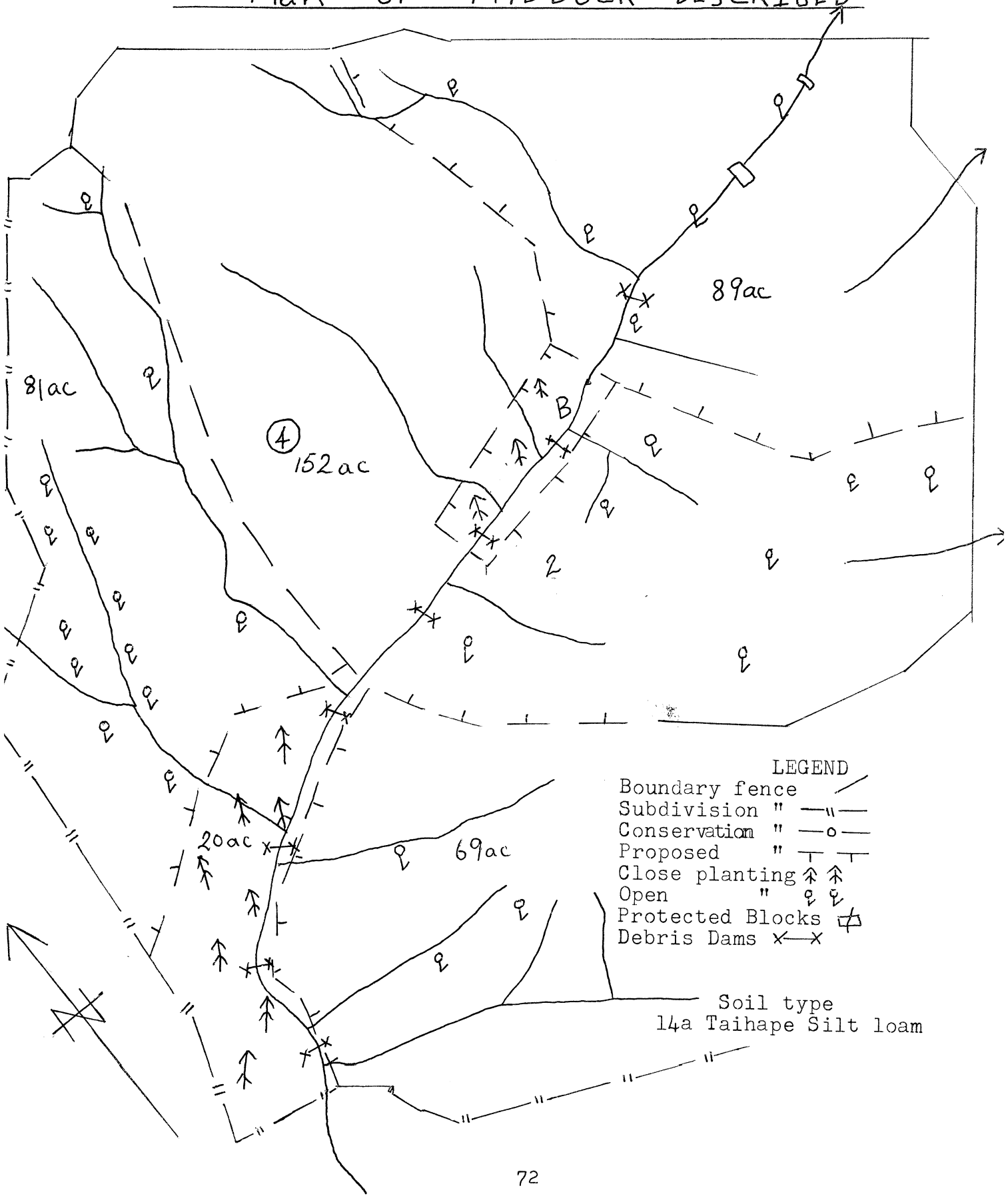
Thus Sheet and Wind erosion are important factors in this block.

Two retired areas will be required up the main creek at the toe of the two most active slump movements. Close planting and Debris dam construction will be carried out within the areas in an effort to halt the gully erosion and toe removal of the slumps. A conservation fence is desirable to facilitate the space planting of the upper reaches of one of the slumps and to enable planting in two other steep degrading creeks. Open planting of all other gullies is essential as well as adjacent hill side planting with two protected blocks above the long retired area.

The pasture is poor, Brown top, Sweet Vernal, Danthonia association with reversion to Tauhinu on the Southerly face. This situation can be much improved by the erection of fences along or on similar lines to those proposed on the plan.

This is followed by an estimate of costs and the works to be done.

Plan of PADDOCK DESCRIBED



Estimate of Costs

	Cost	Rate	Subsidy	Farmer
Retired Area A. 80 ch. fence @ $16 per chain	1,280	2/1	$857	423
Planting 30 acres @ $60 per acre (Poplar Acacia Melanoxylon etc.)	1,800	2/1	1,200	600
Debris dams 15@ $35 each	425	2/1	284	141
Retired area B. 40 chains fence @ $16 per chain	640	2/1	427	213
Plant 5 acres @ $60 per acre (Poplar Melonoxylon etc.)	300	2/1	200	100
Open gully plant	150	2/1	100	50
Space plant 70 acres @ 10 per acre	350	1/1	175	175
Protected blocks 2 @ $50	100	2/1	66	34
Conservation fence 54 chains @ $16/ch	864	2/3	346	518
	$6,509	-	$4,055	$2,454

Farmers Development

85 chains sub division fence @ $16/ch	1,360	-	-	1,360
Topdressing 7 cwt per acre in two flights 140 tons @ $40 per acre	5,600	-	-	5,600
Seed 2,055 lbs clover @ 5lbs per acre	1,024	-	-	1,024
Stock increases 1½ E.E's per acre @ $7.00 per E.E.	4,200	-	-	4,200
	$12,184	-	-	$12,184

The application of super, seed and stock management is usually described along with the first paddock description and any variation is intimated to the farmer in the paddock under description.

These figures for each paddock are collected into summary form.

Summary of Subsidised Items

	Cost	Rate	Subsidy	Farmer
Open Planting Gullies	2,095	2/1	1,397	698
Retirement fence	900	1/1	450	450
Retirement fencing	2,768	2/1	1,846	922
Seedling and Stake planting	800	1/1	400	400
Seedling and Stake planting	2,510	2/1	1,677	833
Conservation fence	1,344	2/3	538	806
Debris Dams	1,625	2/1	1,084	541
Open Planting slump	150	2/1	100	50
Protected blocks	800	2/1	534	266
Space planting	650	1/1	325	325
	$13,642	-	$8,351	$5,291

At this point a visit is made to the farmer who is asked what his development plans are (if any) and his views on priorities with the erosion control programme with a view to the extraction of a five year programme.

For Example

	Cost	Rate	Subsidy	Farmer
Retirement fencing paddock 2	900	1/1	450	450
Close plant " "	800	1/1	400	400
Retirement fencing paddock 4	2,240	2/1	1,493	747
Close plant " "	2,250	2/1	1,500	750
Debris dams paddocks 3 & 4	665	2/1	444	221
Protected Tree blocks paddock 4	100	2/1	66	34
Open gully planting part " 3&4	435	2/1	290	145
Plant Slump Paddock 4	150	2/1	100	50
Space plant part paddock 4	175	1/1	87	88
Conservation fence paddocks 3&4	1,344	2/3	538	806
Total	$9,059	-	$5,368	$3,691

The first years programme is then placed before the eyes.

First Years Programme

		Cost	Rate	Subsidy	Farmer
1968/7	Retirement fence	900	1/1	450	450
1968/8	Planting Seedlings	800	1/1	400	400
	Conservation Fee	119	-	-	119
		$1,819	-	$850	$969

Recommendation and agreement are the final words of wisdom. Hence we have the decision of one of three.

1. A total estimate of subsidised works less than $2,000 can be approved by the Board.

2. A total estimate of subsidised works less than $3,000 can be approved by the District Soil Conservator.

3. Over and above this figure the document requires Soil Conservation and Rivers Control Council approval which often takes no small period of time and hence another advantage of the previous Board work is shown.

The agreement is sent to the farmer, when approval has been received from either of the 3 above, with the new plan and on his signing the dotted line in the presence of a witness and returning same to the Board's Office subsidy is made available.

To keep the farmers interest active visits are made as near as possible to once every 3 months by either the Divisional Conservator or the Works Supervisor to inspect work carried out and to let the farmer know we are taking a

definite interest in his particular problem. A day is spent with the farmer once a year to draw up a programme of works for the coming year and to estimate for him and ourselves the expenditure which will be incurred.

Works can be carried out by any of the following methods.

1. Farmer undertakes his own work.
2. Fencing, tree planting and earthmoving under contract to the Board.
3. Specialized work such as Debris dam building, Thatched spillways and dropstructures etc. by the Board's works unit.
4. Variations and odd mixtures of 1,2 and 3 above occur which are too complicated to explain here.

To these various methods of Farm Plan operation subsidy is granted after a final inspection by a qualified member of the Board's staff. Thus public relations are greatly improved and education of the farmer towards soil conservation ideas move ahead faster.

PROCEDURE FOR PREPARATION OF SUBSIDY PROPOSALS FOR RIVER AND DRAINAGE CONTROL SCHEMES

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1. Introduction

A subsidy proposal for a River Control or Drainage scheme consists essentially of:

(a) A report setting out the need for work to be done and a description of the proposed work.
(b) An estimate of the cost of the work.
(c) A request for subsidy from the central government as part of the cost of carrying out the work.

The actual detail required in preparing the proposal varies from job to job. A small work costing say 200 dollars may require only a brief visit to the site followed by a short paragraph in a report submitted to a Catchment Board, while a proposal for a major scheme is certain to involve considerable field investigation and office planning probably culminating in the presentation of a lengthy report of up to a hundred or more pages complete with plans and other data. This report will be presented to the Catchment Board, the affected ratepayers, the Soil Conservation and Rivers Control Council, and possibly Treasury and Cabinet. The treatment to be given to proposals is determined by the rate of subsidy applicable and the total cost of the work.

2.1 Conditions Common to All Subsidised River and Drainage Schemes

In all subsidised works, part of the total cost of the work is provided by those likely to benefit from the work. It is therefore a most important part of the procedure in the preparation of subsidy proposals to ensure that the local share or 'local contribution' will be forth coming when the subsidy is approved.

Again the subsidy from the central government is not to be wasted because of lack of maintenance. It is a condition on which subsidy is granted that routine maintenance will be carried out when required. An important point in procedure is to ensure that adequate arrangements are made for this when preparing the proposal.

2.2 The Local Contribution

This part of the cost to be paid by the people requesting the work may be provided by a variety of methods depending on whether or not the work is for an established rating area. The procedure may be quite complex even though the cost of the work is relatively small.

If the work is part of a scheme for which a rating area is already established then procedure is simple. The scheme is usually being administered by the Catchment Board or County Council on behalf of the ratepayers and approval of the work by the administering body automatically guarantees the local contribution.

Where only one or two people are involved in works outside established rating areas the usual procedure will be to obtain the initial request for assistance in writing. The approval (in writing if the local contribution is likely to be substantial) of the petitioners to a preliminary estimate of cost should also be obtained before too much investigation has been carried out. When assured of continued interest in the work any further investigations necessary can be carried out and the proposal completed and submitted for approval of subsidy. After the subsidy has been approved the estimated local contribution should be collected before work actually commences. It is a good precaution at this stage to state clearly in correspondence that the cost has only been estimated whereas the subsidy is paid as a share of actual costs. For this reason there may be a balance of local contribution to be paid or refunded.

If more than a very few people are to receive benefit from the scheme and it is not part of an existing rating district it is almost certain that one will have to be established. The procedure for this is covered by legislation and can often be handled best by the local county councils. For this reason the local authority should be informed at an early stage that the proposal is being investigated. If the work is of relatively small cost and of fairly wide benefit a County Council may choose to provide the local contribution from county funds, guarantee maintenance from the same source, and so avoid setting up a new rating area.

2.3 Maintenance

In the case of works carried out for an established or new rating area maintenance costs on river and drainage works are eligible for subsidy at the rate of $1 subsidy to $2 locally contributed. In setting up a new rating area it is important to consider estimated maintenance costs and allow for them in annual charges to be met from rates.

Outside of rating areas maintenance costs are not subsidised. Adequate arrangements for the maintenance must still be made. Generally only one or two people are involved and it is good practice in these cases to obtain a written undertaking from the contributors that they will maintain the work as necessary. Fencing to keep the stock away from young growth in live protection work is often the major item of maintenance required in river works of this type. In the writer's experience a form setting out the possibilities as to balance of local contribution and the

responsibility for maintenance is signed by the local contributor before work commences.

3.1 Maximum Rate of Subsidy Determined by Type of Work

To be eligible for subsidy works carried out in river and drainage schemes must be to the benefit of the nation as well as those locally affected. The return to both parties will be the conservation of a soil or water asset and maintained or increased production.

Central government recognises this sharing of benefit by making subsidies as payment of part of the cost of approved works or schemes.

In this country the maximum share of the cost to be paid by way of subsidy is fixed at standard rates according to the type of work that is to be carried out. These standard maximum rates are $1.00 subsidy to $1.00 local share for drainage works and $2.00 subsidy to $1.00 local share for river works.

There may be exceptions to these rules where higher rates are given in special circumstances. Some special types of river and flood control works are eligible for special rates of subsidy either higher or lower than the standard rate.

3.2 Drainage Works

Works under this heading must benefit more than one property in order to gain subsidy assistance. The work may be the construction of new drains or the improvement of existing drains or watercourses. Associated works such as dropstructures, floodgates, pumping stations etc. necessary for the proper functioning of the drainage system may be included in a subsidised drainage scheme. The object of the work will be to make it possible for the properties adjoining the work to dispose of surplus water from the surface and upper layers of the soil. The subsidised works will not usually include the complete drainage network necessary to drain all of the area being treated, but they will provide outlets on each property so that the drainage can be completed by the various property owners themselves.

The maximum rate of subsidy normally available is $1.00 subsidy for $1.00 contributed by the local beneficiaries of the work.

In special cases where there is a problem of dealing with foreign water the subsidy may be available where the work is to the benefit of a single property.

3.3 River Works

A wide variety of works come under this title the more

usual types being:-

Tree clearing to increase flood carrying capacity;
Erosion control by means of bank protection, groynes, retards, and planting of protective belt of willows or poplars;
Planting to provide material for future river works;
Diversion cuts and channel enlargement;
Stopbanking;
Drop Structures, diversion channels etc.

The work may be a combination of several of the above in a comprehensive river scheme benefiting a large number of people, or it may be a relatively small undertaking of immediate benefit to only one property.

The normal maximum rate of subsidy for river works is $2.00 subsidy to $1.00 local contribution.

3.4 Special Works

Some flood and erosion control works in rivers are eligible for rates of subsidy different from the standard $2 to $1. In this category there is:-

Opening to the sea, lagoons at the mouths of rivers, at $1 to $1
Bank protection with rip rap at $3 to $1
Flood control by the use of detention dams at $3 to $1
Repair of existing control works damaged by flood at $3 to $1.

4.1 Detail of Proposal is Determined by the Estimated Cost

Subsidies for river and drainage works are allocated by the Soil Conservation and Rivers Control Council on behalf of the government. Approval of smaller proposals for subsidy has been delegated to some extent by the Council to District Commissioners of Works and to Catchment Boards according to the estimated cost of the work as follows:-

(a) Drainage works up to $1000 total cost and river works up to $2000 can be approved by Catchment Boards and are known as Board Works.
(b) Drainage works up to $5000 and river works up to $10,000 may be approved by the District Commissioner and are known as District Works.

Works which are beyond these limits or where special features are involved must be submitted to Council for approval and are known as Council Works.

The division of works according to type and to the approval required is shown in Table I.

The degree of delegation of authority to approve is seen to be commensurate with the size and complexity of the work. In making these delegations the Council has very reasonably directed that the amount of detail given in a proposal should be determined on the same basis.

4.2 Proposal for Board Works

Drainage and river works in this category are approved by the Catchment Board without separate reference to the District Commissioner or to the Council. Generally all that will be required in a proposal for a Board Work will be a short report to the Board giving the basic facts viz: need for and description of proposed work, the estimated total cost, and a recommendation as to rate of subsidy for the work.

Records kept on the work should include references to any survey work or plans necessary for its proper execution. If no other record is kept at least a map reference can be very useful in locating the site of the work in the future.

4.3 Proposals for District Works

A proposal for a District Work will be much fuller than that for a normal Board Work. The basic items of the proposal will be dealt with separately in some detail and they will be supported with additional items determined by the job itself. A list of headings for the various items in the proposal might be as follows:-

Name of Work and Catchment Number
Description of Site
History of the problem
Description of Proposed Work
Plans - Locality and Detail
Discussion of Special Design Features
Detailed Estimate of Cost
Discussion of the Economic Factors involved
Consideration of possible alternative designs
Arrangements for Financing Local Share
Maintenance arrangements
Urgency
Notes on Catchment Condition
Request for Subsidy at stated Rate.

The actual headings used for a particular proposal will depend on the nature of the problem and the type of work proposed.

If the work is to be part of an overall scheme, already approved as a larger District or Council Work, some items such as the economics, and the catchment condition, may not have to be dealt with at all. On the other hand if the work is in itself an overall scheme, full Economic Report, classification and Rating Proposals, Soil Conservation Report on Catchment, etc. may be required in the proposal.

4.4 Proposals for Council Works

Works of this size will generally fall in one of two categories:-

(a) The work will form part of an overall scheme which has already been approved in broad outline. The proposal for such a work would be dealt with in similar detail as a District Work of the same type. The detail in the various items would be determined by the nature and complexity of the work itself.

(b) The work will be a comprehensive river control or drainage scheme. A proposal for this type of work will deal fully with all of items listed in 4.3 above for District Works except that if the work is to be spread over several years the description of proposed works and the plans of these works need be in outline only but giving sufficient information to give a reasonably reliable estimate of cost. Approval of a work of this type must give some latitude to adopt better methods or to meet changed conditions as the work progresses and it would be pointless to provide detailed plans for work several years in advance.

After a comprehensive scheme has been approved the annual programme of work for each year must be submitted to Council for approval. The individual jobs covered by the annual programme are then submitted in detail either as District or Council works as appropriate according to cost and special features involved.

5. General Considerations

The details necessary for preparing proposals as listed above should be regarded as guide lines only. Each job must be dealt with according to its merits. A District work approaching $10000 in cost may be quite straight forward, while a relatively small Board Work may require a lengthy investigation and proposal because of unusual features involved.

It should also always be remembered that the local contribution required from one individual for a small Board or District Work may be many times larger than a lifetime of rates paid by another ratepayer towards the cost of a larger overall scheme. Every job is important to some one and from this point of view warrants careful if not lengthy investigation of the factors involved.

6. Acknowledgements

The writer wishes to thank the North Canterbury Catchment Board for permission to prepare and deliver the paper. A great deal of the information included has been taken from circulars issued by the Soil Conservation and Rivers Control Council and this source is acknowledged. Thanks are also

given to the Chief Engineer and staff of the North Canterbury Catchment Board for advice and help in the preparation of the paper.

TABLE I DESIGNATION OF PROPOSALS ACCORDING TO TYPE OF WORK AND TOTAL COST

DESIGNATION Standard Subsidy Rate	TYPE OF WORK PROPOSED		
	DRAINAGE WORKS ⅀1 to ⅀1	RIVER WORKS ⅀2 to ⅀1 (Note 2)	SPECIAL WORKS
BOARD WORKS	Up to ⅀1000 total cost	Up to ⅀2000 total cost	Lagoon openings at ⅀1 to ⅀1 up to ⅀2000 total cost per annum.
DISTRICT WORKS	Up to ⅀5000 total cost	Up to ⅀10000 total cost	Lagoon openings at ⅀1 to ⅀1 up to ⅀10000 per annum Protection with rip rap at ⅀3 to ⅀1 up to ⅀10000 Flood Damage at ⅀3 to ⅀1 up to ⅀10000 in one river due to one flood.
COUNCIL WORKS	Above ⅀5000	Above ⅀10000	All other works (Note 3)

Notes. 1. The standard rate of subsidy is the normal maximum rate. The actual subsidy awarded as the result of a proposal may be less than the standard rate.

2. The ⅀2 to ⅀1 maximum rate for river works applies only where the benefit is to farm lands.

3. Typical of special works which require Council approval irrespective of cost are:-
   (a) Stopbanks to exclude sea water or to reclaim tidal or lakeside flats.
   (b) Major drop-structures, floodgates, check-dam systems and pumping stations.
   (c) All detention dams.
   (d) Subsidised dams for water-supply when the catchment exceeds 20 acres.
   (e) Protection of scenic reserves and domains.

"THE PART TREASURY PLAYS IN CATCHMENT SCHEMES"

G.S. Aburn (delivered by K.C. Durrant)

I propose to discuss in this paper the role Treasury plays in respect of catchment control schemes and of other soil conservation works submitted to the Soil Conservation and Rivers Control Council and to Government for approval. As a background against which we can consider this role, it would be useful if I briefly refer to the general functions of the department.

Functions of Treasury

The Public Revenues Act 1953 is the current legislative authority for the establishment of the Treasury under the control of the Minister of Finance. Treasury is charged with the administration of this Act which sets out the general rules for the receipt, control and expenditure of all public money.

Treasury is thus responsible for:

1. The management of the public finances - it keeps the Government's accounts, prepares the annual budgets and longer term expenditure programmes, arranges finance for approved Government activities, and manages the public debt.
2. Advising Government on financial policy - on the costs and relative priorities of expenditure proposals and how limited available financial and other resources may be most efficiently and economically allocated to alternative uses - this is often referred to as the process of "cutting up the cake".
3. Advising Government on economic policy - by reporting regularly on economic conditions and recommending measures which would assist to fulfil economic policy goals such as full employment, growth in real incomes, price stability, and a favourable balance of external receipts and payments.
4. Implementing financial and economic policy as required by Government.

By virtue of its responsibilities, Treasury is called upon to participate in many fields of Government activity.

Participation in Soil Conservation Activities

One of these fields is of course the Soil Conservation and Rivers Control Council. The Secretary to the Treasury is a member of the Council along with the Permanent Heads of the Departments of Agriculture and Lands and Survey, and of the New Zealand Forest Service. These departments are represented by virtue of their interest and of their ability to assist in the promotion of soil conservation in a practical manner through the use of their own departmental expertise and resources.

On the other hand, Treasury is represented because of its particular interest in the financial aspects of the policy and activities of the Council. During the developmental period of the Council, Treasury although not represented on the Council was able to play a significant part in the formation of Council's policies and in the establishment of the present bases of sharing the costs of major and minor soil conservation works.

The Secretary to the Treasury, or his appointee, attends each of the monthly meetings of the Council, and also participates in the work of ad hoc committees established to consider specific matters of policy and other proposals referred to it from time to time by the Council. Thus Treasury is able to continue contributing actively to the work of the Council.

Consideration of Projects

The Council is called upon to consider proposals for:

Catchment control schemes;
River control schemes;
Farm conservation plans;
Flood control and drainage schemes; and
Single practice proposals, such as conservation fencing, firebreaks, gully control, wind breaks etc. which do not form part of a more comprehensive scheme or farm plan.

Catchment Control Schemes

This type of project involves initially the greatest outlay by Government and farmers alike but attracts eventually perhaps the greatest benefits. Major river control schemes which often form part of wider catchment control schemes could also be said to fall within this category as regards costs and benefits, and therefore my remarks will also have some relevance to such schemes.

As you know, proposals for catchment control schemes generally derive their initial impetus from repeated and serious flooding in the lower reaches of rivers following erosion of hillsides, gullies etc. in the upper reaches of the catchment.

The work undertaken in a catchment control scheme generally falls within two categories:
Firstly - River control works, including provision of stopbanks, training the river and other engineering work; and
Secondly- Soil conservation work, including gully and slump erosion control, full or partial retirement of eroded land, changes in land use and management practices.
Obviously these two portions of the overall scheme require differing approaches from the technical and financial

viewpoints. For instance, the river control work is carried out in a relatively easily defined and restricted area and can proceed relatively quickly as physical conditions permit and as finance is made available, often with the minimum of disturbance to farming. On the other hand, soil conservation works can affect land use and management practices which farmers in the district may have followed for generations.

The standard rate of Government subsidy on river works carried out under the control of catchment authorities is $3 for each $1 contributed locally. The rates of subsidy on soil conservation works vary considerably because of the relationship the cost of the work bears to the benefit the farmer obtains in increased production and gross farm income, to the benefits accruing downstream both in the river and to the surrounding land.

These standard rates of subsidy have been determined by the Council over a period of years. Treasury, through its participation in the work of the Council, has contributed to the deliberations leading to the setting of these standard rates.

Consideration of Scheme Proposals

When detailed proposals for a catchment control scheme have been prepared they are submitted by the catchment authority to the Council for consideration. However, before the Council considers them they are examined thoroughly by professional staff and where necessary discussed with or referred back to the authority for further consideration and perhaps amendment of the scheme of works to be carried out. As justification for proceeding with the expenditure involved it is the practice for the authority to prepare and submit an economic report indicating the costs and benefits of the overall scheme.

Treasury regards these economic reports as vital to the proper assessment of the justification for embarking on catchment control schemes.

The Department of Agriculture is generally responsible for the preparation or examination of economic reports in relation to schemes for rural development, including those now under discussion, because they usually involve estimating increased productivity expected to arise from the improvement of local water and soil conditions, and from improved land use and management practices. The availability of these reports ensures that the approving authority, i.e. the Council, the Minister of Works or the Cabinet Works Committee as the case may be, has an assessment of the overall economic benefit accruing from a particular scheme on which Government expenditure is to be incurred by way of loans, grants or subsidies.

To digress for a moment, I feel that it would be

appropriate at this stage for me to clarify one aspect of detail in respect of the basis of assessing costs for the purpose of economic reporting. That is to say that, on purely economic grounds, a scheme of this nature can be considered justified only if all the assessed benefits exceed the total expenditure incurred. The Government expenditure in subsidies must be included as part of the overall cost of the scheme, along with all other expenditure such as that met from ratepayers' contributions and farmers' "on farm" costs incurred in increasing productivity to take advantage of the improved water and soil conditions.

I am aware that the view is held in some quarters that the Government subsidy does not form part of the cost which is to be compared with the benefits accruing.

Returning now to the general discussion - before a catchment control scheme, or for that matter any scheme involving Government expenditure, comes before the Soil Conservation and Rivers Control Council it will have been thoroughly examined in all respects, i.e. the engineering and soil conservation angles will have been passed by the professional staff of the Council; the economic justification will have been reported on and concurred in by the Department of Agriculture. Furthermore, the staff of the Council will have indicated in the submission to the Council that funds and other resources will be available to implement the schemes should it be approved.

These are the matters that Treasury seeks to have fully covered particularly in respect of all major proposals submitted to the Council for approval. You will gather from what I have said that Treasury does not become involved directly in the detailed day-to-day preparation and examination of such proposals.

Treasury relies on the professional experts in the engineering and soil conservation fields to critically examine all proposals and on the Department of Agriculture to prepare or examine reports on the economic justification for rural development projects. Treasury must satisfy itself that the financial aspects of each proposal are adequately considered. Close contact is maintained with the Department of Agriculture and the methods of project evaluation used in assessing the viability of projects such as these are discussed with the Department regularly.

Large schemes approved by the Council for implementation required financial approval by the Minister of Works or by the Cabinet Works Committee where the cost in subsidy exceeds certain limits.

Recommendations are made by the Council to the Minister of Works in appropriate cases. However, when the scheme requires approval by the Cabinet Works Committee, a report must be prepared by Treasury for the information of the Committee.

The need for these reports arises from a Cabinet rule that any proposal involving Government expenditure submitted to Cabinet or one of its Committees must first be reported on by the Treasury and an appropriate course of action recommended.

These Treasury reports are addressed to the Minister of Finance who makes them available to his colleagues prior to the submission being examined by the Cabinet Works Committee. Even although Treasury is represented on the Council, it is required to prepare a report in order that Ministers may know Treasury's views on:

- the justification for the project
- the degree of priority it warrants
- whether funds are available within
- Parliamentary appropriations.
- whether it is consistent with current policies
- whether this is the most economical way of carrying out the work.

Conclusion

To sum up, Treasury's part in the decision-making process in catchment control schemes (or any other major rivers control and soil conservation project for that matter) is primarily as financial adviser to Government. As a member of the Council Treasury participates fully in the discussion of schemes submitted for approval and pays particular attention to the economic justification for schemes and to their relative priority having regard to the finance available. For schemes that require Cabinet Works Committee approval the procedure of reporting to the Minister of Finance is an extension of the work of the Treasury on the Council.

THE ECONOMIC EVALUATION OF INVESTMENT IN LARGE-SCALE PROJECTS - AN ESSAY TO RECOMMEND PROCEDURES

R.C. Jensen
Lincoln College

The task of assembling recommendations on the use of project evaluation procedures has been attempted previously. For example, the "Green-Book" has laid a long-respected basis for evaluation work; more recently documents from the United States Senate have emerged as valuable standard references.

Discussions continue at academic levels on both theoretical aspects and the application of discounted flow techniques. In recent years the limitations of discounted flow techniques have been recognised and emphasised, and amid the volumes of literature on this subject there has not appeared, to my knowledge, a simple statement of recommended practices and standards which will materially assist those whose interests lie only in the empirical side of discounted flow techniques. Our experience at Lincoln and the discussions of the Seminar recently completed have forced a realisation of the difficulties facing many who are expected to provide economic information on proposed projects. The diversity of background of those whose duties include economic evaluation indicates that few have been exposed to "professional training" in discounted flow techniques and that they gain small comfort from books and professional journals.

Obviously the lack of a series of uncomplicated recommendations for use at "grass-roots" level exists because it would be considered professionally naive to publish them, even though a writer may have established them subjectively for his own work. In the interests of uniformity, I intend then to be naive, to provide some recommendations which I believe would not be frowned upon too heavily by both respected practitioners and academics, and which probably represent the consensus of informed opinion. No theoretical justification is offered in support, since this would presuppose familiarity

* This paper was prepared consequent to, and at the request of, the Seminar on Project Evaluation. It contains some material already mentioned in the papers earlier in this book, and has benefited from the discussions of the Water Resources, Land Development, and Forestry/Land Development workshops of the Seminar. The constributions by the discussants of these workshops is gratefully acknowledged, also the advice received by Mr.R.W.M. Johnson, Professor J.G.Yoho, Mr.A.C. Norton, Mr.A.C. Lewis and Mr.H.J. Plunkett on earlier drafts; all responsibility however lies with the author.

with the theory by many who have not seen the literature, and would complicate unnecessarily a paper which is meant to be free of academic complexities. I fully realise that many may disagree with some of my recommendations, but submit this paper as an interim guideline, until a better one is produced. And this will be welcome. In the meantime, the Agricultural Economics Research Unit at Lincoln College will be guided by these standards for evaluation work commenced in 1968 and later.

The recommendations in this essay refer to the evaluation of large scale projects - defined for our purposes as projects initiated above the level of the firm; from irrigation projects to reservoirs and so on. The wide range of projects which possibly fit into this category means that detail is impossible in a paper of this nature. The essay considers primarily evaluation procedures in the New Zealand agricultural scene[1], and is limited to established discounted flow techniques. A working knowledge of these techniques is assumed.

The following topics are dealt with:

1. Objective of the Investigation
2. Scope of the Project
3. Viewpoint
4. Terminology
5. Representation of Benefits & Costs
6. Period of Analysis
7. Discount Rate
8. Index of Overseas Exchange
9. Output Prices
10. Sensitivity Analysis
11. Double-counting
12. Presentation of Results
13. Expected values
14. Re-appraisal
15. Investment & Financing
16. Policy Conclusions.

1. Objective of the Investigation

It is desirable that economic reports be preceded by a clear statement which provides perspective on the evaluation and the reason for the study. This statement should specify the economic facts it is hoped to demonstrate, and the particular decision-making situation to which these facts are appropriate, e.g. - some reports are prepared primarily as methodological demonstrations, others are empirically

1. It should be stressed that the application of discounted flow techniques in "non-agricultural" investment evaluation has been successfully practiced for several years. This essay however, avoids discussion of all but agricultural applications.

oriented using established methods; some are basically "research" reports intended for example to demonstrate desirable or undesirable directions of development, others may be intended directly as guides to individual cash investment decisions.

The specific aim of the project should be outlined. For example, one or more of the following may be intended:-

(a) to provide information for an accept-reject decision on a particular project,
(b) to compare two or more alternative projects,
(c) to calculate the maximum investment advisable to achieve specific benefits,
(d) to compare different rates or timing of investment.

The prime consideration for specifying the aim of the study should be the question posed to the practitioner, remembering that discounted flow techniques are reasonably flexible and that a slavish adherence to the "usual" procedures of calculations may not produce results in a satisfactory form. If possible the political and social framework within which the decision is to be made should be outlined, as well as the flexibility available to the practitioner in terms of the scale of the project.

2. Scope of the Project

A precise description of the project(s) should be provided. Physical boundaries should be defined along with sufficient technical information to enlighten but not confuse the uninitiated. Technical information may be valuable to later workers in the same area, and if this is likely, it is better retained in an appendix than lost to posterity. Simple maps of project location and boundaries of influence could be included. It is important to signify the relative size of the project and whether or not externalities are likely to be important, and the direction of their influence, even if their effect is not included in later calculations. Any technically limiting factors should be recognised.

3. Viewpoint

Analysis should define and state the viewpoint from which the study is executed.

(a) National viewpoint. The effects of project establishment should in the case of large-scale projects, be traced as far as possible throughout the economy, and will include benefits and costs accruing to the nation as a whole. These are usually evaluated through effects on national income. In the case of large-scale projects which involve overseas sales and purchases the national viewpoint should include consideration of the net effect of the project for overseas exchange. Adequate

evaluation of smaller projects, e.g. drainage schemes involving a limited number of farmers can undoubtedly be carried out from the national viewpoint without the inclusion of "spillover" or exchange benefits.

(b) Regional or District viewpoints. These studies include the effects of the project on regional or district populations and local governments.

(c) Industry viewpoint. The effect on an industry, through both pricing and production, of the establishment of a project.

(d) Individual viewpoint. The effect of a project on an individual firm its operation and profits.

Other viewpoints should be recognised if necessary. Projects which could involve public money are correctly evaluated from the national point of view. Studies of farm development are useful from the national point of view only if some policy suggestions are possible and are given.

It will readily be recognised that some effects of a project may be benefits from one point of view and costs from another, and vice versa. Further, some policy questions, e.g. a desirable level of public subsidy, can frequently be answered only if evaluation is attempted from more than one point of view.

4. Terminology[2]

Benefits are defined as the increases or gains in the value of goods and services which result from conditions with the project, as compared to conditions without the project. Benefits should be measured net of indirect and direct costs, and include both tangible and intangible benefits.

Tangible Benefits - those which can be expressed in money terms.

Intangible Benefits - those which are not fully measurable in money terms, or may not be satisfactorily expressed in money terms, in formal analysis.

Primary (or Direct) Benefits - the value of goods and services directly resulting from the project less direct and indirect costs incurred in realisation of the benefits.

Secondary (or Indirect) Benefits and Spillovers - the increase in the value of goods and services which indirectly result from the project under the conditions expected to

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2. The definitions of Benefits and Costs are modified and condensed from my earlier paper. (Paper 4.)

occur with the project as compared to those without the project. Secondary benefits and spillovers are measured net of any costs which have to be incurred to realise them.

The simplest solution to the common imprecision of definition of these terms is that spillovers should be acknowledged when a study takes the national point of view, and that secondary benefits occur locally and should be recognised in studies when a local or regional viewpoint is taken.

Costs

Direct Costs - includes the value of goods and services used in constructing, operating and maintaining the project. This category of costs includes all other identifiable expenses, losses, liabilities and indirect adverse effects connected with the project, whether or not compensation is involved, whether tangible or intangible. Costs of investigation, both technical and economic, should be estimated and recorded separately as a cost of the decision making process, but not included in the analysis.

Indirect Costs - the value of goods and services over and above those included in direct costs needed to make the immediate products or services of the project available for use or sale.

Overseas Exchange Benefits & Costs

The net requirement or contribution of a project to overseas exchange is appropriate to evaluation of large projects in the New Zealand economy. Some index of the premium on overseas exchange (at f.o.b. prices) should be applied as a measure of the net social benefits or costs from this source. These benefits could be both primary and secondary and both tangible and intangible.

The terms benefits and costs should be seen as terms which specifically include non-cash allowances. Where these are not included in the study, the terms "benefits" and "costs" are inappropriate. At least four situations, with specific terms describing the flows, can be distinguished:-[3]

(a) Individual Viewpoint - Cash Flow Studies - where cash flows only are considered, and the net cash flows are required;

b_j = receipts or expected receipts

c_j = payments or expected payments

V = present value of receipts

3. Notation used is that outlined in my earlier paper. (Paper 4.)

C = present value of payments

$V-C$ = net present value (or private net present value) of project.

This case is similar in effect to the discounted cash flow (D.C.F.) method commonly used by accountants.

(b) Individual Viewpoint - Including Depreciation or Renewal Funds, or other Non-Cash Allowances

b_j = income or expected income

c_j = expenditure or expected expenditure

V = present value (worth) of income

C = present value (worth) of expenditure

$V-C$ = (private) net present value, or (private) present worth of project.

(c) Large Scale Projects - Cash Flow Studies Expected cash flows only, from a regional, industry or national viewpoint, and would include usually only primary benefits with direct and indirect costs;

b_j = returns or expected returns

c_j = costs or expected costs

V = present value of returns

C = present value of costs

$V-C$ = (social) present worth or (social) present value of project.

(d) Large Scale Projects - Including Non-Cash Allowances Both primary and secondary benefits are included, perhaps with some values imputed or simulated, and with allowances for other factors such as net requirement of overseas exchange:-

b_j = benefits or expected benefits

c_j = costs or expected costs

V = present value of benefits

C = present value of costs

$V-C$ = (social) present worth or project.

5. Representation of Benefits and Costs (Income, Expenditure, etc.)

Benefits and costs included in the calculations should be clearly listed and the method of calculation described - preferably in reasonable detail, in an appendix.

All foreseeable consequences of a project should be taken into consideration. However, the limitations of our techniques demand that the benefits and costs be represented in money terms if they are to enter an economic evaluation. The first problem then is to devise the most satisfactory way of representing the various classes of benefits and costs in money terms.

In large scale projects a broad spectrum of benefits exists - from actual money benefits to intangible benefits. Actual cash flows present no problems of measurement. Similarly, intangibles, by definition, cannot be included in the discount analysis. An indication should be given however of the nature of the intangibles - whether qualitative or quantitiative, political or social - and the section of the community likely to be affected. Where the reason is not obvious the classification of a benefit or cost as intangible should be justified by listing the reasons for avoiding measurement.

Between these extremes are benefits which can be represented in money terms with varying degree of accuracy, comfort and effort.

The synthesis of expected cash flows from both expected technical coefficients (e.g.yields per acre) and expected price and cost figures, is often necessary. The matter of forward estimates of prices for use in the calculation of cash flow is considered later. Preceding papers will have made it clear that small variations in the magnitude and sequence of cash flows may have an alarming influence on the criteria developed for decision making. Every effort must be made to represent expected cash flows as faithfully and as objectively as possible. The following points might aid in this objective:-

(a) Estimates of technical coefficients should aim at accuracy, and the tendency to "play safe" by deliberately incorporating conservative estimates should be avoided. Most estimates of future production, particularly in the long term, are uncomfortably subjective; using conservative figures does not eliminate or minimise error, but probably ensures its existence.

(b) Technical change is characteristic of the Agricultural sector, and therefore its incorporation in the synthesis of cash flows is highly desirable if the period of analysis is more than 5 or 10 years. Discounted cash flows would normally compare the "with" and "without" situations;

the "without" situation is often mistakenly assumed to be a "status quo" situation. Technical change is an integral part of both the "with" and "without" situations. An estimate of the rate of technical change to be included in the analysis could be obtained from national or area trends etc.

(c) Input Prices are constantly changing, usually increasing. If the decision maker is to be provided with a realistic appraisal of an investment situation the observed facts of unit price increases or decreases should be included in the evaluation. If output prices are assumed to be constant, and unit input prices are increasing a "cost-price squeeze" is thereby built into the flows in the same way as it might well be expected to operate in reality. Estimates of unit price increases are available for some types of farming.4

(d) Taxation should not be included in studies undertaken from the national viewpoint. Mention should be made however, of the likely effect of taxation on the behaviour of people affected by the scheme. Both "before" and "after" tax figures should be presented for studies undertaken from the individual point of view. From the regional viewpoint taxation represents an important transfer to or from the region.

(e) Depreciation presents a problem with no unique solution. A recommended treatment, as a simple rule of thumb, of depreciation and replacement costs is as follows - until the project becomes "established" and the new "equilibrium" level of production is obtained, cash flows should include net replacement costs for equipment at the termination of its physical life. After this point the sinking fund formula should be used to calculate an annual equivalent or annuity to represent net replacement costs. This annuity is then accepted as the value of depreciation. If the development period is short, i.e. less than 5 years, the annuity should be calculated for the whole period of analysis.

(f) Residual Values. The suggested method of accounting for depreciation in the calculation of flows aims at maintaining the investment intact and in an efficient operating condition. Residual values can as a general rule be ignored, especially in longer term studies, and certainly when flows are discounted to infinity.

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4. e.g. (1) Meat & Wool Boards' Economic Service Cumulative Cost Index. (2) Input Price Index from B.P. Philpott, et al. "Estimates of Farm Income & Productivity in New Zealand 1921-65, A.E.R.U. Publ. No.30.
(3) Index of Prices Paid by Dairy Farmers, Farm Economics Section of New Zealand Dairy Board.

6. Period of Analysis

If a project is expected to continue for a certain specified time period, obviously this period will dictate the period of analysis and the consequent calculation of cash flows. Many agricultural projects, e.g. drainage and irrigation channels etc., can have an unlimited life if regularly maintained. Further, it may not be possible to forecast at what date structures become obsolete or redundant. The recommended procedure for permanent structures whose life cannot be estimated with reasonable accuracy is:-

(a) calculate cash flow for the development period
(b) capitalise to infinity cash flows which are expected beyond the new equilibrium position.

The termination point of the development period may be difficult to define due to very small changes in the flows, as the new equilibrium position is approached. As a further rule of thumb it will probably be satisfactory to capitalise flows when successive cumulative present values vary by as little as 5.0 - 7.5 per cent.

In long-term projects, there is little difference between the discounted value of cash flows which terminate at infinity and at say 100 years. If, however, comparison is intended with projects of a similar technical nature, which have been evaluated for a given number of years, further results referring to the same time period should be obtained.

7. Discount Rate

Amid all the discussion on discount rate, the ultimate decision is usually which rate to use, as long as it is within about 5% to 7%. If the recipients of benefits are specifically those who incurred the costs, the cost-of-capital technique outlined elsewhere (Paper 4) would provide an appropriate discount rate. In other cases, specifically where studies are undertaken from the national point of view, the recommended discount of Government Security yields on outstanding long-term loans at the end of the previous financial year. These are quoted in the Reserve Bank of New Zealand Bulletin in the table "Share Prices and Interest Rates".

Foreign capital should be discounted at the rate of interest on the most recent World Bank loans. This information is usually available from Reserve Bank publications.

8. Index of Overseas Exchange

This index is meant to represent the degree of over- or undervaluation of the New Zealand currency. This index would vary from time to time as the economic position in

New Zealand vis-a-vis the rest of the world varies. No suitable index can be recommended at this stage. Reference should be made to the Treasury Department or to the Reserve Bank, if an estimate of this index is required.

9. Output Prices

In historic studies the question of output prices has a selfevident solution. Inevitably actual prices are used. Only when special aspects of historical studies are emphasised should actual output (and input) price be deflated.

In forward looking studies there is no unique solution to the dilemma facing those who require estimates of future prices, particularly over several years. Since both the magnitude of the cash flows and their sequence affect the usual criteria, both aspects must be considered. The disturbance due to output price fluctuations which defines the sequence of fluctuations in cash flows is best overcome by the assumption of a constant price level. If available data show some long term trend in output prices and it can reasonably be expected to continue, this may be included. However, with our present state of knowledge any attempt to forecast the fluctuations in various commodity prices would be unwise.

If we can accept the desirability of using a constant price for forward-looking studies, the next question is the level of the constant price. Should the price be based on past, present, optimistic or pessimistic price levels? Probably past prices are one of the most satisfactory indication of future price levels; on this basis the following are suggested:-

(a) for short-term studies (i.e. less than 20 years), output price levels should be the mean of the previous five years' annual average levels;
(b) for long term studies, output price levels should be the mean of the previous ten years' annual average levels.

If these are not readily available, the Government Statistician's figures should suffice. If the above is adopted there will be little variation in prices between practitioners and between studies commenced in consecutive years.

If reliable long-range projections of prices are available they should of course be used. If production arising from the project is expected to influence prices significantly, the prices with and without the project could be averaged to obtain the price incorporated in the budgets. Ideally a range of prices should be used - this will be discussed in Section 10.

10. Sensitivity Analysis

If assistance from a computer is available, practitioners should feel obliged to explore thoroughly the behaviour of criteria over a reasonable range of coefficient values. Recommended areas of analysis are:

(a) The shape of the present value curve (Paper 7), will indicate the sensitivity of present value to the discount rate, and should be explored over a range of discount rates. Does any small change in discount rate materially affect present value? If so, what is the characteristic of the budgeting which is responsible? Should this characteristic be removed or treated in a different manner?

When comparing two or more projects present value curves should be plotted to determine at which interest rate, if any, the present values of the projects are equal. If this occurs, is this discount rate significant for any reason, and what is its relation to the respective internal rates of return?

Simple computer programmes are available or can be written to calculate present values over a range of interest rates. If this range is wide enough the programme will readily show the internal rate of return (or if there are multiple internal rates of return).

(b) The sensitivity of present value to output price levels should invariably be explored. How does present value change with reasonable changes in price levels? At what price level does present value become zero, and is this a price which can be reasonably expected to occur? How far is this price from prevailing price levels? When complementary products are produced, e.g. wool and lamb, the product prices should be varied simultaneously, and by similar percentages, to avoid unnecessary confusion which often adds nothing to the general results. Prices should be varied at units of one per cent to allow comparision with other studies.

(c) The sensitivity of present value to doubtful or critical coefficients. If the derivation of any coefficient has been based on unsatisfactory evidence, or if the coefficient is obviously critical to the study, a full exploration of its influence on present value should be undertaken, over all reasonable ranges of its value. What percentage change in present value occurs from a given percentage change in the coefficient? What percentage change is necessary to force present value to zero? Input prices, rate of investment, and technical coefficients should be considered

for sensitivity analysis.

11. Double-counting

Instances of double-counting have occured in overseas studies where some primary benefits were counted twice, both as primary benefits and as spillovers. This has not, to date, occurred in New Zealand studies. Benefits should be systematically calculated and every care taken to ensure that no item appears in more than one category of benefit. A common point of confusion relates to the inclusion of increases in land values and income increases. It is not valid to impute to a project increases in the capital value of land which are expected to result from increased income which has already been included in the flows. This would, in effect, be double-counting of the effect of increased income, since land values are related to income-earning capacity.

12. Presentation of Results

The format of results and the criteria developed will depend on the original aim of the exercise. Some general suggestions can be made:-

(a) That the evaluation of a project is best made in terms of present values, as the most meaningful criterion. For reasons outlined earlier in this volume (Paper 7 particularly) the internal rate of return has serious disadvantages compared with the present value criterion. Present value, however reflects the size of the project, and gives an unsatisfactory indication of the efficiency of capital. The V/C ratio should be used in conjunction with present value (V-C) if the efficiency or productivity of capital is required.

(b) Comparisons between two or more investments are probably best made in terms of present value. Only if the present value curves (i.e. present value plotted against discount rate) of each investment are known not to intersect at discount rates between either internal rate of return and a reasonable upper limit of commonly used discount rates, can the internal rate of return contribute a great deal to interpretation of results.

(c) Various modifications of the V/C ratio are often useful, when particular aspects of the desirability of the investment require further elaboration. Some of these have been mentioned by Mr. Johnson in Paper 9. The V/C ratio refers to the ratio of gross benefits to gross costs, and unless both of these have been calculated it should be specified that the ratio used is a modification of the usual V/C ratio.

(d) A statement of opinion on the likely magnitude and effect of intangible benefits or spillover effects should be included.

(e) That the values of V-C and V/C be specifically stated in terms of the items included in the calculation, e.g.

Primary	V-C and V/C	- including primary benefits only,
Secondary	V-C and V/C	- including secondary benefits when calculated,
Total	V-C and V/C	- including all tangible primary, secondary, spillover and exchange benefits.

(f) If variations in the scale of the project are possible, results should include conclusion on the "best" scale for implementation.

13. Expected Values

If estimates of the probability distribution of possible (e.g.price) situations are obtainable, the analysis will benefit from the calculation of an expected value of the present value.

14. Re-appraisal

Reports should be prepared in a manner which facilitates periodic re-appraisal if technical or economic conditions in the years following the original report prove to be significantly different from those assumed in the original study. Rapid changes in markets, or production methods, could make re-appraisal desirable.

15. Investment and Financing

Some practitioners, e.g. catchment board officers, must be concerned both with the economic desirability, and the source of finance, of a project. It is imperative however that these two aspects remain separate in the compilation of a report. Any project should be recommended or rejected largely on its economic desirability, and not whether it will appeal to those who may be required to vote for its approval, or whether or not it will make a significant difference to the current burden of rates.

When both investment and financing aspects of a project have to be considered, each aspect should be the subject of a separate report. The investment report will provide information on the economic desirability of the project *per se*, and the financing report will give recommendations on the source of finance.

16. Policy Conclusions

No investment study should be considered to be complete unless accompanied by a statement expressing the author's views on the appropriate action which the decision maker should take. Irrespective of whether the study has been commissioned by a government body or a local organisation, it is the duty of the practitioner to weigh all the tangible evidence, advise on this basis, and indicate the weight of intangibles associated with a project. He will be ideally and prominently placed in relation to the project he has evaluated and should advise the decision maker on the alternatives available and the steps he considers appropriate.

DISCOUNTING TECHNIQUES

R. Jensen.

Mr. Jensen outlined the principles of discounting to the training course for the benefit of those not familiar with them. He recommends the following references as sources of both information and examples on discounted cash flow techniques:

1. DISCOUNTING AND OTHER INTEREST RATE PROCEDURES IN FARM MANAGEMENT

   by CHISHOLM, A.H. and DILLON, J.L.

   Professional Farm Management Guidebook No.2
   Department of Farm Management, University of
   New England, Armidale. 1966.

2. THE ECONOMICS OF CAPITAL EXPENDITURE

   by MIDDLETON, K.A.

   Statements on Accounting Practice No.5 (Revised Ed.)
   Australian Society of Accountants. 1964.

3. THE FINANCE AND ANALYSIS OF CAPITAL PROJECTS

   MERRET, A.J. and SYKES, A. Longmans, 1963.
   (A more comprehensive volume).

AN ILLUSTRATIVE EXAMPLE OF EVALUATION PROCEDURES (DRAINAGE SCHEME - NORTH CANTERBURY)*

A.C. Norton & R.C. Jensen**

1. Objective of the Investigation:

To provide information on an accept-reject decision on the Osborne's Drain Improvement Scheme.

2. Scope of the Project:

2.1 The scope of the project is to prevent flooding and to improve the efficiency of drainage, so that the area can be developed to its full potential as high producing land. The accompanying plan shows the boundaries of the area and the location of the work, proposed in the scheme. All properties within the scheme will have a direct outfall into an improved channel which will be maintained in the future as a public drain in a classified rating district.

2.2 In general the proposed scheme of work will be the provision of flood pumps at the site of the present Osborne's Drain floodgates and the enlargement of the present channels to contain all flood waters except under extreme rainfall. Under average winter conditions, it is assumed that the surface level of the water in the main channels will be 3 ft. below ground level, in order to keep the ground water level (which is saline) below the root zone of all plants.

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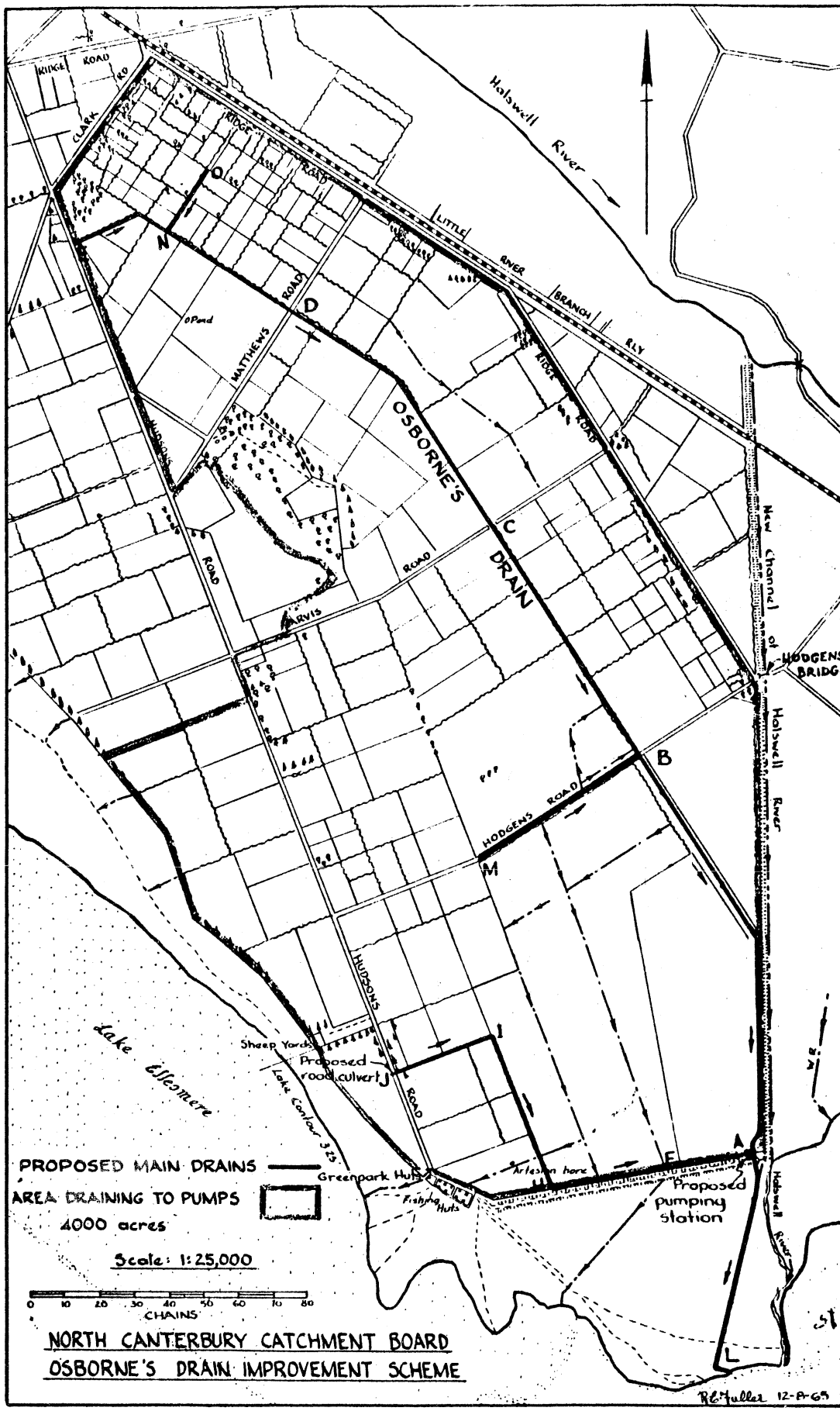
* This evaluation has been prepared in accordance with the procedures set out in the paper - "The Economic Evaluation of Investment in Large Scale Projects - An Essay to Recommend Procedures" by R.C. Jensen which is published in the Proceedings of a New Zealand Seminar on Project Evaluation in Agriculture and Related Fields, Lincoln College, Agricultural Economics Research Unit Publication No.48, 1968. In general, this report is a modification of an economic report prepared by A.C.Norton for the North Canterbury Catchment Board in February 1963. Wherever possible data has been brought up-to-date. Nevertheless, it should be read and understood, primarily as a type example and not as a re-evaluation of the Osborne's Drain Scheme. The permission of the North Canterbury Catchment Board to reproduce data is gratefully acknowledged.

** A.C. Norton - Classifier, North Canterbury Catchment Board.
R.C. Jensen - Senior Lecturer in Economics, Lincoln College.


Halswell River
KIRK ROAD
CLARK
RIDGE ROAD
LITTLE RIVER BRANCH RLY
MATTHEWS ROAD
OSBORNE'S DRAIN
HUDSONS ROAD
ARVIS ROAD
RIDGE ROAD
New Channel of Halswell River
HODGENS BRIDGE
HODGENS ROAD
Halswell River
HUDSONS ROAD
Lake Ellesmere
Sheep Yards
Proposed road culvert
Lake Contour 3'2.5
Greenpark Huts
Artesian bore
Fishing Huts
Proposed pumping station
A
B
C
D
E
I
J
L
M
N
O
PROPOSED MAIN DRAINS
AREA DRAINING TO PUMPS
4000 acres
Scale: 1:25,000
0 10 20 30 40 50 60 70 80
CHAINS
NORTH CANTERBURY CATCHMENT BOARD
OSBORNE'S DRAIN IMPROVEMENT SCHEME
R.C. Fuller 12-A-69

2.3 Extending in a north-westerly direction from near the mouth of the Halswell River, the major part of the Osborne's Drain catchment, prior to European settlement, would have been a shallow bay covered by the high levels of Lake Ellesmere. In 1889 the Government constructed the Halswell Canal and the spoil on the right bank from the end of the high ground just downstream of Hodgen's Bridge for some 130 chains towards the Lake formed a substantial embankment, a bank known as Osborne's Bank was constructed at approximately right angles to it in a westerly direction for about 83 chains where it merged into high ground near the present Greenpark Huts. Osborne's Bank which has a top width of 10 ft. and a height of 8 ft. above M.S.L. is stone faced on the Lake side. The westerly side of the catchment from the end of Osborne's Bank is protected from Lake Ellesmere by land which varies between 7 and 8 ft. above M.S.L. while on the N.E. and N.W. perimeter there is the boundary with the Halswell River catchment with levels in excess of 8 ft. The accumulation of water in the area is due solely to the run-off from rainfall and not from any spring action. The line of Osborne's Drain follows road and drain reserves laid off at the time of the original land surveys. The drain at present discharges via a manually controlled floodgate direct into Lake Ellesmere.

The scheme envisages that the water at present discharged into the Lake by four drains (not floodgated) located to the west of Hudson's Road between the Greenpark Huts and Jarvis Road and the small floodgated drain at OM 27.43 chains on Osborne's Bank will be brought to the pumping station located at the present Osborne's Drain floodgate. The acreage of occupied land within this proposed catchment of the pumping system is 3,944 acres.

The characteristic features of the area are:

2.3.1 The extreme flatness and low lying nature of the land. From Osborne's floodgate along the line of the drain to near the top of the catchment at Hudson's Road the ground level rises 3.71 ft (2.81 ft to 6.52 ft.) in a distance of 4 miles 44 chains. The area of land below the 6.5 ft. contour is approximately 57% of the total catchment.

2.3.2 The area of land flooded and the duration of the flooding on some occasions. It is estimated that during periods that Lake Ellesmere is at high levels for several weeks, 800-1,000 acres are flooded. Of the land not flooded, upwards of 2,500 acres has severely impeded drainage with the water-table virtually at ground level.

2.3.3 The salinity of the soils. It is estimated that 2,106 acres, at the lowest levels, is of medium salinity with patches of high salinity, a further 1,452 acres is weakly saline with some areas of medium salinity and 386 acres on higher ground on the margin shows nil or slight signs of salinity.

2.3.4 The low production from poor quality pastures on the areas of medium and high salinity which is also the region where flooding occurs. On average grazing is only available for about six months of the year.

2.3.5 The complete absence of stock shelter on all but the highest ground in the catchment. The region is very exposed to both the north east wind which whips down out of Gebbie's Pass, after being funnelled there by the configuration of the Lyttelton Harbour and the winds from the southerly quarter.

2.4 There are 19 holdings completely or partly within the Catchment. However, as 5 of the whole or part properties (65 acres in area) are located on the higher ground and will receive no benefit from the proposed work, they have been neglected in the subsequent analysis and estimates. The area of the 14 properties is 3,879 acres within the catchment and 1,196 acres outside the catchment, to give a total of 5,075 acres. Of the 3,879 acres, 669 acres on 6 properties are held under L.I.P. tenure and the balance is freehold.

3. Viewpoint of Investigation:

The investigation of the scheme is from the national viewpoint. Externalities to the New Zealand economy are not likely to be significant and therefore have not been included in the calculations.

4. Present Production:

The present production is as follows:-

The stock carried is for the total area of the properties (within and outside of catchment) while the crop acreages are for land completely within the catchment. Several of the properties have various combinations of the various types of production.

Town supply dairy cows	-	8 properties, 344 milking cows and 130 replacements.
Butterfat Supply dairy cows	-	3 properties, 72 miling cows and 43 replacements together with pigs.
Beef Cattle	-	3 properties, 77 head of various descriptions.

Grazing Cattle	-	2 properties, 85 head of dairy heifers and cows.
Fat lamb production	-	6 properties, 4,455 ewes with 951 replacements.
Barley	-	3 properties, 69 acres.
Perennial rye-grass seed	-	1 property, 30 acres.

5. Expected Future Production:

The construction of the proposed work will allow each farmer to carry out developmental work within his own property with a resultant increase in production. The areas of the differing benefits within the 3,879 acres are estimated as follows:

Major benefit	- 2,106 acres	- low lying land below the 6.5 ft. contour which on average is of moderate salinity.
Minor benefit	- 1,452 acres	- land about and immediately above the 6.5ft. contour which on average is weakly saline.
No benefit	- 321 acres	- land at the highest elevation in the catchment.

The 1961 Government Capital Value of the 2,106 acres (no homestead sites included) is $125,640 or $86.60 per acre.

In assessing the increase in carrying capacity and crops it has been assumed that the present types of farming continue in the future under the present efficiency of management. After 10 years of development work the following is the estimate of the increase in stock numbers and crops for the benefiting area of 3,558 acres.

Town supply dairy cows	- 86
Butterfat supply dairy cows	- 29
Dairy Replacements	- 36
Beef cattle - breeding cows	- 50
Ewes on fat lamb production	- 4,225
Other sheep - hoggets & rams	- 509
Barley - acres	- 146
Rye-grass seed - acres	- 30

6. The Period of Analysis and Discount Rate:

The analysis has been taken to infinity and the discount rate at 5½ per cent.

7. Costs and Returns:

The costs and returns are set out in Table I. The following provides some details on the preparation of the figures.

7.1 The Scheme costs (Row A) of $42,000, obtained from the engineering report includes the estimated expenditure on, pumps; electric motors; pumping well and foundations; building at pump site; improvements to just over 8 miles of drains; culverts, and engineering fees for supervision once the work commences.

7.2 The maintenance (Row B) is the estimated annual charges to clean the 8 miles of drains; labour for regular checking of pumping station, screens and electrical equipment; insurance of building and plant; plant maintenance and the power charges to pump out drainage water, plus water used in de-salting and or irrigation of the land.

7.3 The sinking fund (Row C) is the amount of money which has to be set aside annually and invested at 5½ per cent compound interest in order to have $8,000 available to pay for the replacement of the pumps and motors at the end of twenty years. $8,000 represents the anticipated purchase price of pumping equipment.

7.4 Row D - (the summation of rows A, B, & C) - is the total of the direct costs.

7.5 The annual land development costs (Row E) also includes the increase in capital outlay of new buildings, plant and additional livestock required as a consequence of the land development. It is assumed that these costs will be incurred as equal increments over a five year period. The details of the total costs are in Appendix I.

7.6 Row F is the increased annual farm running costs incurred in obtaining the increase in gross farm returns as outlined in 7.9 below. Included in these costs is the running expenses, repairs and maintenance and depreciation of the items under land development and capital outlay in 7.5 above. The increased annual costs at the end of 5 years are given in detail in Appendix II.

7.7 Row G - (the summation of rows E & F) - is the total of the indirect costs.

7.8 Row H - (the summation of rows D. & G) - is the total of the annual costs.

7.9 The increase in annual gross farm returns (Row I) is the monetary value of the expected increase in future production given in paragraph 5. Details of the increased returns, at the end of the 5 year development period, are in Appendix II.

7.10 The net annual returns or the direct benefits (Row J) obtained by subtracting Row I from Row H.

7.11 The cost of investigations for the scheme, estimated at $1,615 have not been included in any of the costs as set out in Table I.

8. Technical Change:

8.1 In the "without" situation there is no possibility of increased technical efficiency giving any increase in returns from the area. The drainage and local flood problems of the region place an absolute limitation on how the area is used without a scheme.

8.2 In the "with" situation it is anticipated that technical change in this area as well as the country as a whole will increase gross returns. This has been allowed for in the increased annual gross farm returns (Row I) at the compounded rate of 1½ per cent.

9. Input Prices:

Throughout the country input prices are increasing. Therefore, cash flow streams of Rows E, and F have been increased by the compounded rate of 2½ per cent. Annual maintenance costs (Row B) are not expected to increase in the long term. Technological improvements in drain maintenance methods, will possibly lead to lower maintenance costs, and these are assumed to compensate for increasing pumping costs.

10. Discounting Analysis:

The discounting procedures applied to the costs and returns are detailed in Table II and Table III.

11. Results:

The results can be summarised as follows:-

From Table III - Present Worth of Returns = 1,801,536 ---(V)
" " II - " " " Costs = 1,641,199 ---(C)

The present worth of the net returns or the direct benefits of the project

= (V - C)
= $160,337 (which is positive)

The returns/costs ratio = $\frac{V}{C}$

= 1.098

12. Policy Conclusions:

12.1 The economic benefits - that is the net present worth of the project are estimated at $160,337. This amount does not include any allowance for indirect benefits which we feel are insignificant and need not be considered in the decision to accept or reject the project.

12.2 The authors consider that from the national viewpoint there is economic justification for proceeding with the project.

12.3 The report does not include any information on the financing of the project which could be the subject of a separate report.

APPENDIX I

Estimate of development and increase in capital outlay.

Development costs - per acre			
Internal farm drainage	$9.00		
Farm Shelter	7.50		
Sub-division fencing	19.00		
Fertiliser	27.00		
Seeds	11.00		
Cultivation	11.50		
Stock Water	2.00		
Lucerne establishment	1.00		
De-salting	22.00		
On 2,106 acres at	$110.00	=	$231,660
New Buildings			
Two houses and layouts at $9,000	$18,000		$21,000
Hay barns	3,000		
New Plant			
One tractor and hydraulic fittings			$3,000
Additional Livestock			
115 cows at $100	$11,500		
4,225 ewes at $4.30	18,168		
84 rams at $18	1,522		
50 beef breeding cows at $100	5,000		
1 bull (beef breed)	150		$36,340
TOTAL development and capital outlay			$292,000

APPENDIX II

(a) Increase in annual gross returns at the end of 5 years.

Town Supply Dairying	$18,920
Butterfat Dairying (including Pigs)	2,726
Beef Calves	1,260
Cull Cows	262
Fat lambs	15,100
Wool	17,768
Cull ewes	2,680
Barley	6,204
Perennial rye-grass seed	1,080
	$66,000

(b) Increase in annual farm running costs at the end of 5 years.

Stock purchases	$5,415
Dairy shed expenses	480
Veterinary expenses and animal health	810
Herd testing	105
Crop harvesting	1,405
Machine dressing and certification	200
Freight and cartage	1,900
Feed charges	1,350
Fertilizers	4,680
Seeds	1,040
Weeds and pest control	885
Wool expenses	1,425
Vehicle and motor expenses	2,105
Repairs and maintenance	5,860
General and unforeseen	660
Wages	7,750
Rates	1,220
Insurances	220
Depreciation	2,490
	$40,000

TABLE I - PROFILE OF COSTS AND RETURNS

ROW YEAR	1	2	3	4	5	6
DIRECT COSTS:						
A scheme	$42,000					
B Annual Maintenance of Scheme	2,400	2,400	2,400	2,400	2,400	2,400
C Sinking Fund	230	230	230	230	230	230
D TOTAL DIRECT COSTS: (A & B & C)	$44,630	$2,630	$2,630	$2,630	$2,630	$2,630
INDIRECT COSTS:						
E Annual land development costs	$58,400	59,860	61,356	64,462	66,074	-
F Increase in annual farm running costs	8,000	16,400	25,215	34,460	44,152	45,256
G TOTAL INDIRECT COSTS: (E & F)	$66,400	76,260	86,571	98,922	110,226	45,256
H TOTAL ANNUAL COSTS (D & G)	$111,030	78,890	89,201	101,552	112,856	47,886
I Increase in Annual Gross Farm returns	$ 13,200	26,796	40,797	55,212	70,050	85,321
J NET ANNUAL RETURNS or DIRECT BENEFITS (H - I)	-$97,830	-52,094	-48,404	-46,340	-42,806	+37,435

TABLE II - PRESENT WORTH OF COSTS

Discount Rate 5½%

(a) Years 1 to 5

Year:-	1	2	3	4	5
From Table I Row H	111,030	78,890	89,201	101,552	112,856
Present Worth Factor	.94787	.89845	.85161	.80722	.76513
Present Worth	105,242	70,879	75,964	81,975	86,350

TOTAL PRESENT WORTH YEARS 1 to 5 = $420,410

(b) Years 6 to infinity

Present Worth of years 6 to infinity, at the end of year 5 is capitalisation of uniform cost stream

= $47,886 x 33.3333
= $1,595,531

(The capitalisation rate should be the discount rate less the rate of increase in unit costs in this case 5½% less 2½% = 3%. This provides an approximate true discount rate.)

Present Worth at beginning of year 1 of $1,595,531 is that sum discounted for 5 years

= $1,595,531 x .76513
= $1,220,789

(c) Total Present Worth of Cost Stream - Years 1 to infinity

Total Present Worth = (a) + (b)
= 420,410 + 1,220,789
= 1,641,199

TABLE III - PRESENT WORTH OF INCREASED RETURNS

Discount Rate 5½%

(a) Years 1 to 5

Year:	1	2	3	4	5
From Table I - Row I	13,200	26,796	40,797	55,212	70,050
Present Worth Factor	.94787	.89845	.85161	.80722	.76513
Present Worth	12,512	24,075	34,743	44,568	53,597

TOTAL PRESENT WORTH YEARS 1 to 5 = 169,495

(b) Years 6 to infinity

Present Worth of years 6 to infinity at the end of year 5 is capitalisation of uniform return stream

= 85,321 x 25.00 Capitalisation Rate = (5½ - 1½)% = 4%

= 2,133,025

Present Worth at beginning of year 1 of 2,133,025 is that sum discounted for 5 years

= 2,133,025 x .76513

= 1,632,041

(c) Total Present Worth of Increased Return Stream - Years 1 to infinity

Total Present Worth = (a) + (b)

= 169,495 + 1,632,041

= $1,801,536

RECOMMENDATIONS FROM RESEARCH ON PERSUASION FOR SOIL CONSERVATORS

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Because of the demands of propagandists and advertisers a considerable amount of research has been undertaken by social psychologists on the technique of persuasion. The purpose of this paper is to bring to the notice of soil conservators those practical findings of this research which seem relevant to obtaining agreement amongst property owners for a "community scheme".

In general the research work suggests that a logical and sincere approach produces the desired results and that tricks and gimmicks which may give short term results should be avoided.

Needs and Motivation

A community scheme which meets the perceived needs of the people within a district is likely to be adopted as long as it is expected to put money into the pockets of the residents, reduce their risks, increase their pride of ownership and save them work. Of course the scheme may do these things but the ratepayer may not perceive this. Hence the words "perceived needs" were underlined above.

This principle is central to advertising and promotion. "Find out the needs of your customers and then show how your product meets their needs", is the advertisers motto. You will notice that advertisements stress benefits rather than specifications. Hatters say that a hat makes young men look more mature and old men look younger rather than referring to the technical specifications of the hat. Similarly soil conservators should attempt to show farmers that the benefits of a scheme far outweigh the costs rather than stress the technology of the scheme. The cusecs of water, the kilowatts of electricity and the cubic feet of concrete are specifications, but the farmer wants to know the net benefits to him.

In order that the individual farmer may perceive the outcome of the scheme in clear cut terms, it may be necessary to evaluate the effect of scheme on each farm and show him how he can exploit the scheme to his benefit. Because this will involve development budgeting, I hope that soil conservators will use the computer programs now available to remove the tedious arithmetic.[1]

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1. Computer Program for Development Budgeting. K.T. Sanderson and A.T.G. McArthur. A.E.R.U. Publication No.45, 1967.

There is one difficulty which makes it hard for some soil conservators to see things from the farmer's point of view. All professional groups tend to develop their own value system and there is a tendancy to attempt to impose this system of values on others. Veterinarians feel badly about infected stock and want farmers to feel likewise. Some accountants feel satisfaction in a high level of equity and want businessmen to feel the same way. Similarly soil conservators feel badly about slipping hillsides and tend to expect farmers to have the same sense of values. This ethnocentrism sometimes leads soil conservators to overvalue the outcome of soil conservation measures from the farmers point of view and this tendancy has to be restrained.

Message Formulation

There is now a considerable amount of experimental evidence about whether a message should be formulated to give only the pros or whether it should also include the cons. The results of many experiments indicate that two-sided messages (where the pros outweigh the cons) are more effective in causing opinion change than one-sided messages under these conditions.[2]

1. When the other point of view will be presented from another source.
2. When the persuader requires a long term rather than a short term response.
3. When the audience is well educated.

These three conditions appear to fit the description of the majority of landowners voting for or against a scheme. Hence it would seem advisable to stress both the benefits and the costs of a scheme but to point out that the benefits outweigh the cost.

Credibility of a Source

There will be more opinion change in the desired direction if the communicator has a high credibility - a technical term which has become generally well known due to the so-called credibility gap of the present American administration. People accept a communicator as credible if they accept him as an expert and as trustworthy.

One technique in this kind of research is to subject experimental groups to the same taped persuasive message and to measure opinion change with a questionnaire. In one group the tape is attributed to a credible source and to another the taped message is attributed to a non-credible source.[3]

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2. Horland, C.I.et.al. Experiments on Mass Communication, Princeton Univ. Press 1949.
3. Horland, C.I.et.al. Communication and Persuasion. Yale University Press, 1953.

Research work indicates that the motives attributed to the communicator can affect his success in influencing an audience. This gives the government servant an advantage in New Zealand when it appears that he has no personal axe to grind.

Work in this field supports the view that an organisation and its staff must build up confidence with farmers. Short run tricks to gain acceptance of an issue now may lead to a credibility gap which can make further persuasion difficult.

Participation

Many experiments have shown that audience participation aids the persuasion process by overcoming resistance.[4]

This notion has become firmly entrenched in our buzz group system of running conferences where decisions are made. In dealing with farmers we must build an effective grass roots organisation so that people feel that the scheme is theirs even though the numerous committees never seem to do much and cause delays and frustrations. They are not so much a part of the decision making system, they are part of the persuasion and educational process.

Contrary Attitudes of Influentials

Certain individuals within a group have a greater influence on opinions of others than their numerical strength. If these influentials have attitudes contrary to a scheme they may wreck it. It may be worthwhile identifying influentials within a committee or within a community and exerting more than average persuasive influence on them. In doing this it is worthwhile considering the factors which may underlie their attitudes. These causative factors can be classed as follows.[5]

(a) Factual cause. Here the attitude arises from past experience and the expectations based on this past experience. If a farmer planted trees at the head of a gully to stop it spreading but found that he had to clear up both trees and debris instead of just debris after a bad slip, then on this experience he may have developed unfavourable attitudes towards soil conservation work. Such attitudes can be changed

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4. Lewin, K. Studies in Group Decision in Cartwright and Zander "Group Dynamics". Row, Peterson 1953.

5. Sarnoff, I. and Katz, D. The motivational basis of attitude change. J. Abnorm. and Soc. Psychol. 49: 115, 1954.

with new facts and by persuading him that he is making a hasty generalisation based on inadequate experience.

(b) Social cause. Some attitudes are based on the opinion of those in the group to which the individual belongs. If all the people within an individual's group are against a conservation scheme, it may be difficult to get him to change his mind. In general, it is best to change all the people within his group concurrently or transfer him to another group who have pro attitudes. For instance a committee man subject to the pressures of conservative opinion in the local gentlemen's club may change his opinion if he can be persuaded to spend a day with an enthusiastic discussion group who want the scheme.

(c) Ego defensive causes. Attitudes can have an ego defensive basis. These occur in many ways. One may despise nongraduates in order to inflate one's limited ability. Such attitudes are likely to be persistent. Other ego defensive attitudes extinguish in time. For instance a farmer may have committed himself to a belief that the scheme won't work and any withdrawal from this viewpoint would mean loss of face. He obtains satisfaction from his present response of being pig-headed. Continued persuasion may merely reinforce this existing response. However by abandoning the issue for a period of time his response may extinguish. In fact such individuals have been known to become enthusiastic protagonists.

In general the more objective and factual one can be in evaluating a scheme and the more farmers learn about it, the less likely socially and ego defensively induced attitudes are likely to arise. Implementation is likely with real understanding. If there are no facts and farmers cannot understand the scheme (because of its complexity) then persistent and contrary attitudes which impede implementation are likely to cause delays.[6]
The use of cost benefit studies both for the district and the farm seem to be indicated together with a painstaking educational programme where necessary.

Conclusion

The conclusion from this paper suggests that a sincere and logical approach to persuasion is likely to lead to implementation in the soil conservation field.

General Reference

"Persuasion. How Opinions and Attitudes are Changed"
H.I. Abelson, Springer, New York. 1959.

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6. Churchman, C.E. and Ratoosh, P. Innovation in Group Behaviour. International Conference on operational Research 2nd, p.122, Aix-en-Provence, 1960.

DECISION AND SCHEDULING PLANS FOR SECURING DISTRICT AGREEMENT ON SOIL CONSERVATION AND RIVER CONTROL PROJECTS

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One of the key factors in the success of soil conservation and river control work is the vital step of securing agreement amongst property owners that the scheme should go ahead.[1] It is frequently this step which delays a project and hence reduces its value.[2] This paper lays out a procedure for deciding on the methods to use and suggests a way of scheduling these methods. These procedures have proved successful in extension planning and can be expected to be equally useful in soil conservation work. The paper does not lay down a recipe for persuasion. I assume that each case will be different and will require a different strategy.

The purpose of the decision phase is to select the optimum strategy mix (or combination of extension methods) which lies within the resources available so as to maximise the probability of securing agreement after a given time elapse. This part of the procedure has the advantage of making those concerned define their objectives clearly, and makes them conceive, evaluate, and select an optimum strategy mix.

The purpose of the scheduling phase is to draw up a schedule of activities and hence commit members of an organisation to an agreed upon plan. This ensures that priority jobs get done and that unimportant jobs do not cause side tracking. It also provides a focus for co-ordination within and between organisations co-operating on the project.

A schedule of activities is an extremely valuable tool for the administrator who has to control the project. Ideally there should be a system of feeding back information about the progress of the project so that the administrator can make modification from time to time. I will not be elaborating on feed back systems in this paper.

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1. I am grateful to Mr. Alan Norton of the North Canterbury Catchment Board for briefing me on the activities of soil conservators.

2. I assume that all soil conservation and river control projects have a positive value both to the farmer and the nation. As human beings prefer benefits to arrive sooner rather than later, delay reduces value.

Decision Phase.

1. Definition of the objective.

Having clear cut objectives is half the battle in planning. It not only makes for good decision-making but it also provides the motivation to execute plans which have been made. Objectives can be defined in a variety of ways:

(a) Achieve a given objective with a minimum cost.
(b) For a given cost (or set of resources), maximise the level of the objective (e.g. profit).
(c) Maximise the probability of obtaining the objective within the resources available.

The last way of expressing the objective (c) seems the appropriate way of defining the objective for securing agreement on soil conservation and river control projects.

Beware of the fallacy which attempts to get the maximum for the minimum. The minimum means expending no resources on attempting to influence the district about the scheme. We can expect no result to come from such a strategy!

2. Diagnosis of factors likely to hamper agreement being reached.

Here those concerned with making the decision should list the key factors which may stop farmers voting for the scheme. Each situation will be different. They could be:

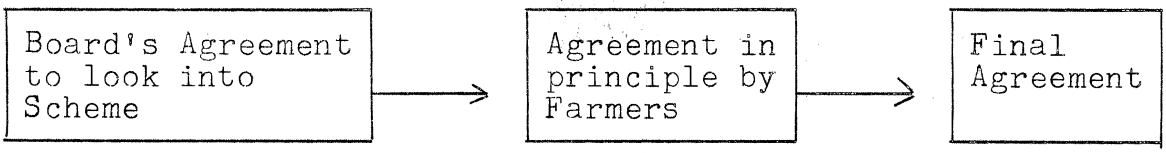
(a) Lack of information on the costs and benefits of the scheme by individuals.
(b) Low income of some farmers preventing them capitalising on the scheme.
(c) Nearness to retirement by older farmers thus making long term development (because of scheme) unattractive to them.
(d) Negative attitude of influential property owners.
(e) Destructive and irresponsible criticism by Government Departments in the district.

Such a listing at least ensures that these key factors have been considered and often such a diagnosis results in sub-objectives in the final plan. The above set of factors could result in these sub-objectives:

"All farmers in the scheme to learn the cost and benefits for them to be derived from the installation of the scheme."(a)
"Co-operation of other Government Departments be gained before selling scheme." (b and e)
"Influential property owners (with negative attitudes) to have attitudes to the scheme changed positively."(c)

A diagnosis of key factors often results in problems being split up into bits, each of which is quite simple to tackle by itself. Frequently a problem breaks itself up

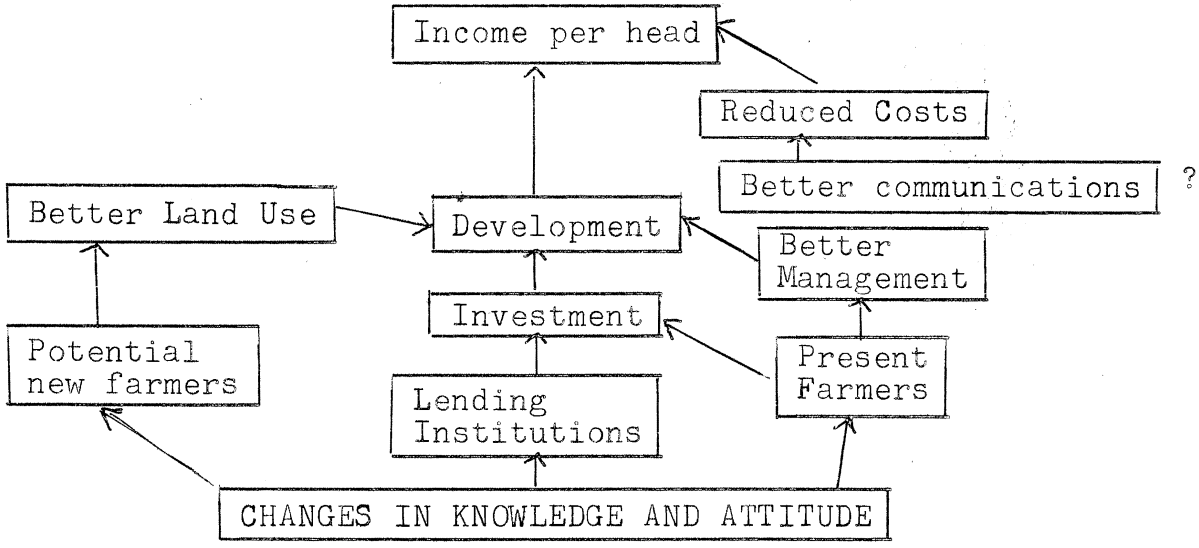
into a sequence of sub-problems such as is shown below:



Here the problem of securing final agreement can be broken up into three sub-problems: the problem of getting the Board's agreement to look into the possible scheme, the problem of getting agreement in principle, and the problem of securing final agreement. This gives a sequence of objectives which require their separate strategies. Each can be scheduled as the time comes.

Sometimes problems can be analysed by way of means-end analysis. The diagram below shows a means-end analysis[3] used in an extension plan made out for the Development of the Hokianga County.[4]

Means-end Analysis of Factors in the Development of Hokianga



This analysis indicated that extension activities should aim at changing the knowledge level and attitude of "potential new settlers", "present farmers" and "lending institutions"

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3. See "The process of management" Newman, W.H., and Summer, C.E. Prentice Hall, New Jersey, U.S.A. Cpt.12 p.255.
4. "An Extension Plan for the Hokianga County", A.T.G. McArthur, and John Askew. Auckland Advisers Conference 1968.

towards farm development in Hokianga. As a consequence the extension plan was geared to these three audiences.

The term means-end derives from the fact that in a situation such as the one depicted above, a means becomes an end as we move back down the chain. Greater income per head is the final objective. This can be brought about by means of development. This means becomes an end when we consider means of bringing about development, "Better Land Use", "Investment" and "Better Management". The means of Better Land Use becomes an end when we encourage farmers from outside the district to buy several farms and amalgamate them.

3. Limit Within Which Plans must fall.

Only a certain amount of resources of men and money can be devoted to a particular project within an organisation. It is usual for management to decide initially how much cash and man-power it can devote to reaching agreement on a project. This will in part determine the methods that can be chosen.

Most organisations can depend on gaining co-operation from other organisations within the district, government departments, the press, N.Z.B.C., and farmers organisations. It can be worthwhile using the resources of these organisations too. The plan then becomes a centre of co-ordination and co-operation.

4. Possible Strategies.

It is usually better to think up as long a list as possible of strategies before evaluating them, and then selecting the mixture which lies within the resources available. Being critical of strategies (which is essential when evaluating them) tends to stultify creativity.

For a soil conservation-river control scheme, the following strategies might be of value:

- S_1 Tour to inspect a similar scheme.
- S_2 Field day on farm making good use of similar scheme.
- S_3 Regular circular letter to farmers about scheme.
- S_4 Strategic visits to influential farmers by Board staff.
- S_5 Visits to all farmers to explain scheme by Board staff.
- S_6 "At Homes" by Board Chairman and staff to explain scheme in several locations during a week.
- S_7 National Farming Paper success stories about similar schemes.
- S_8 Exhibit at local A and P show with staff in attendance.
- S_9 Meeting about scheme with prestige speaker.
- S_{10} Unstructured small group meetings about district problems.
- S_{11} Briefing and dinner for associated organisations.

5. Evaluation and Selection.

Predicting the effect of a strategy is extremely difficult because there is scarcely any information about the relative effectiveness of methods of communication. Furthermore such research is extremely difficult to do because the effect of a method is likely to vary with the user, the audience and the message. To make it more complicated methods interact. We therefore have to apply some judgement about the expected value of a method.

The best procedure is to rank the possible strategies in order of value. Then score the highest ranking strategy as 100 and score the expected value of the other strategies relative to this. Next calculate the cost (in terms of staff days) for each strategy and calculate the expected value/cost ratio. The results of these steps are shown below:

Strategy	Relative Value	Cost (in staff days)	Value/ Cost
S_5	100	50	2.0
S_6	50	10	5.0
S_1	35	10	3.5
S_3	30	8	3.7
S_4	20	15	1.3
S_2	15	5	3.0
S_{11}	10	7	1.4
S_{10}	10	20	0.5
S_7	5	$\frac{1}{2}$	10.0
S_9	4	2	2.0
S_8	3	30	0.1

After this, rank the strategies in order of their value/cost ratio and calculate the cumulative cost. Select down the list until the cumulative cost equals the time available. If 86 days were available (this is the limit within which selected strategies must fall) then we would select S_7, S_6, S_3, S_1, S_2, S_5 and S_9 as shown on following page.

Strategy	Value/Cost	Cumulative Cost
S_7	10.0	½
S_6	5.0	10½
S_3	3.7	18½
S_1	3.5	28½
S_2	3.0	33½
S_5	2.0	83½
S_9	2.0	85½

This procedure will not be tremendously accurate but at least it will prevent the least efficient strategies getting into the scene. By using numbers instead of words to represent judgement of value it often becomes clear that certain strategies cost a great deal and are probably not very effective.

Scheduling.

A schedule provides a listing of the activities to be performed, their specific purpose, who is responsible and the timing. It is a good idea to call a meeting with both staff and co-operating organisations to help draw up the schedule so that everyone has an opportunity to participate in the planning.

Something must be said about the specific purpose. This defines the behaviour response required in the audience as a result of the particular activity. Thus if the activity is a meeting at which a lecture is to be given on the costs and benefits of stop banks and pumps, then the purpose would be "Farmers to learn the costs and benefits of stop banks and pumps". Notice that the purpose is not to tell farmers about the cost and benefits of stop banks and pumps.

With this specific purpose we have asked for an overt response in terms of additional information. We could also include an overt response as a specific purpose, "Farmers to vote for scheme".

A clear specific purpose is a very important guide to planning any message.[5]

The following is a hypothetical schedule based on the previously selected strategies.

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5. See "How to Construct a Talk", A.T.G. McArthur. Canterbury Chamber of Commerce Agricultural Bulletin No.433, 1965.

Schedule for Scheme

Date	Specific Purpose	Method	Who responsible
May 6	Farmers to be informed about general nature of scheme and forth-coming tour.	Circular letter	Soil Con.1
June 3	Farmers to learn costs and benefits (generally) of scheme	Tour	Soil Con.1 Soil Con.2 FAO (D.of Ag.) S.C.O. (MOW) Engineer
July 1	Farmers to be informed about results of tour and learn of forth-coming field day.	Circular letter	Soil Con.1
July 1 - 19	Farmers to learn of cost and benefit on their farms of the scheme	Individual Visits	Soil Con.1 Soil Con.2
July 22	Farmers to be informed about costs and benefits of scheme (gener-ally) etc. etc.	Field Day	Soil Con.1 Soil Con.2 FAO (D.of Ag.) S.C.O. (MOW)

It is useful to have a Bar chart which shows what activities should be in progress in any one week.

Bar Chart showing Activities Associated With the Scheme

Activity	Apr. 26	May 13	May 27	June 10	June 24	July 8	July 22
Prepare circular letter	X——				X——		
Prepare for Tour	X		X——				
Visits						X————	
Prepare for Field Day			X-				X——

This scheduling takes a great deal of effort out of running co-ordinated activities of this kind. It also makes it clear to outsiders that extension officers know what they are trying to achieve.

Conclusion.

There is no strange and mysterious process for persuading people to a particular viewpoint. The key factor is to go about it in a logical and systematic way. It is hoped that as a result of this paper soil conservators will adopt a planned approach to their work with the same alacrity that they hope farmers will adopt a planned approach to farming.

AN INTRODUCTION TO NETWORK ANALYSIS FOR SOIL CONSERVATORS

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1.0 Introduction

A project in soil conservation can be subdivided into a network of individual jobs which contribute to its achievement. A study of the logical sequence of jobs needed to complete a project can be of immense value to the men in charge of it. Network analysis, critical path analysis and project evaluation and review technique (PERT) are all near synonyms for the analysis of job scheduling of a project.

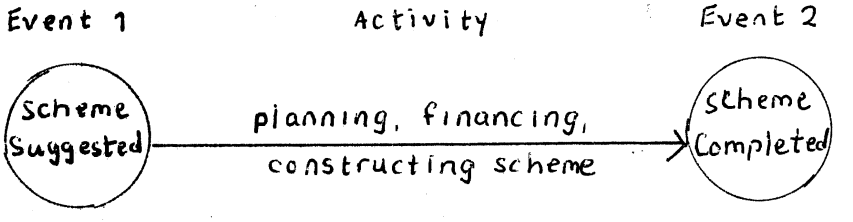
Network analysis is being used widely in industry and business. It is the basis of scheduling and controlling moon rocket manufacture and is used routinely in construction jobs. Network analysis has been used for new product establishment and the installation of electronic data processing system in offices. The technique is less than ten years old, yet of the operation research techniques available, this method is by far the most popular. Its use expanding at an explosive rate. I believe that it has possibilities for soil conservation and river control schemes.

Its main use in planning lies in the area of control of the execution of a project with network analysis it is possible to see which jobs within a project are "critical" and which are "slack" so that resources can be allocated to the critical jobs in the project. This makes sure they are achieved on time and do not hold up the entire project.

2.0 Network Construction

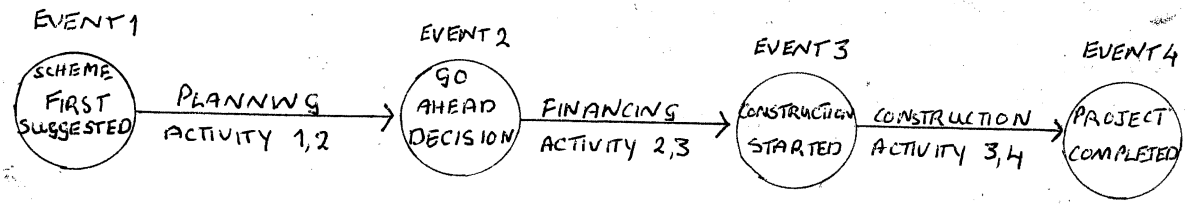
The first step in network analysis is to draw up the network of jobs which are needed to complete the project. For this a large piece of paper is required together with the co-operation of the people concerned with the project whose intimate practical knowledge of the business is essential.

Jobs are represented by nodes and arrows. For instance a drainage project involving a pumping station could be represented like this

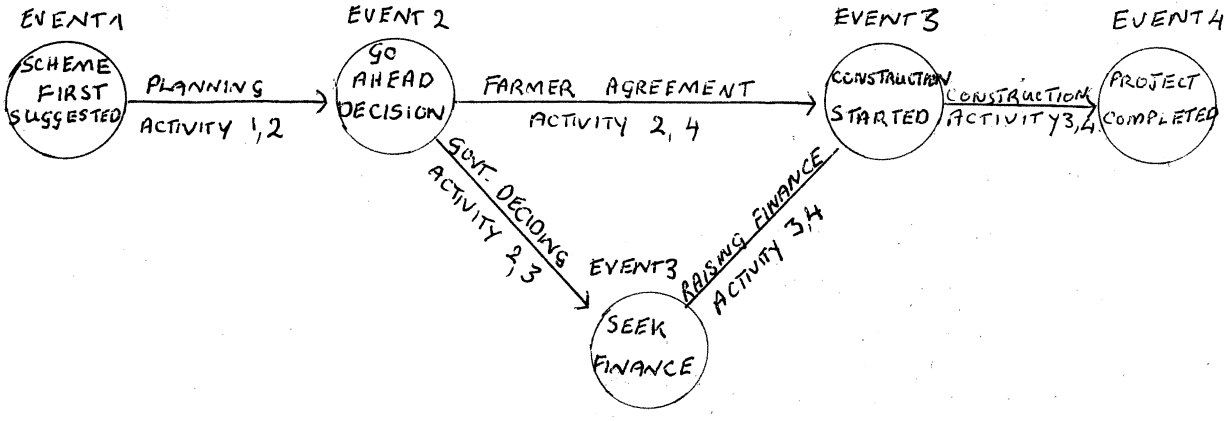


The nodes represent "events" in time and mark the beginning and end of a job or activity as it is usually called. The planning, financing, and construction of a scheme is the activity in this case. It starts with the event of the first suggestion of the scheme (at some moment in time) and ends at another node when the scheme is completed - another event.

However a project like this can be broken down into a network of activities as shown below.



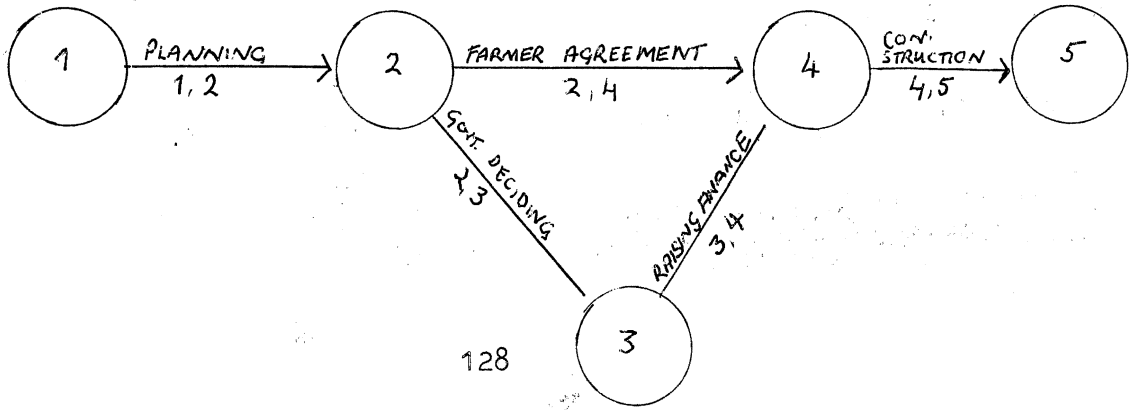
This network is a simple chain. In practice the network will be more complex.



Drawing a network of this kind can be a rewarding occupation in itself. The chances of overlooking vital steps is much reduced particularly when the construction of the network is a team job.

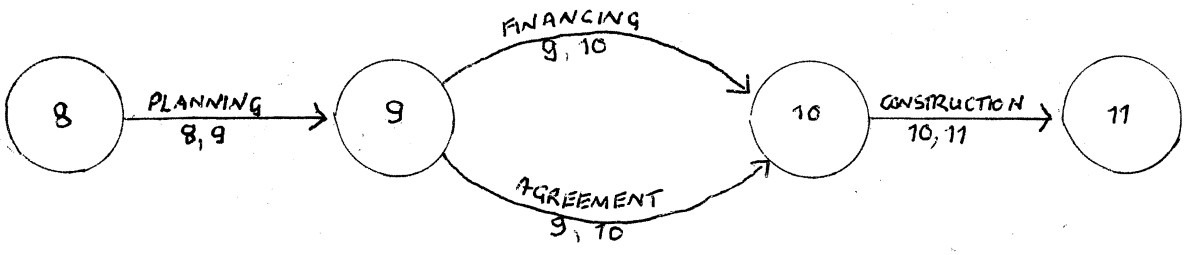
Activity Numbering - the ij system

If the events represented by the nodes are numbered then each activity can be identified by two numbers - the ij system.

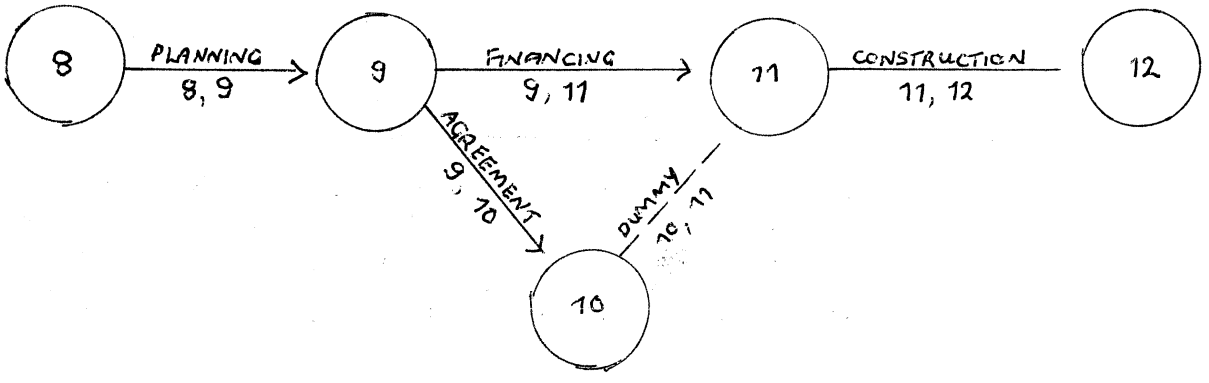


Thus the activity of securing "farmer agreement" becomes coded as "activity 2, 4", being numbered by the events 2 and 4 which precede and follow it. The only rule that must be followed in using this convention is that the second number (j) must be greater than the first (i).

However this procedure of coding requires the introduction of dummy activities, otherwise there can be confusion between activities. Take for instance this situation.



Both Financing and Agreement have the ij code of 9,10 in the diagram above. In order to overcome this we introduce a dummy activity which takes zero time to perform and which is represented by a dotted arrow.

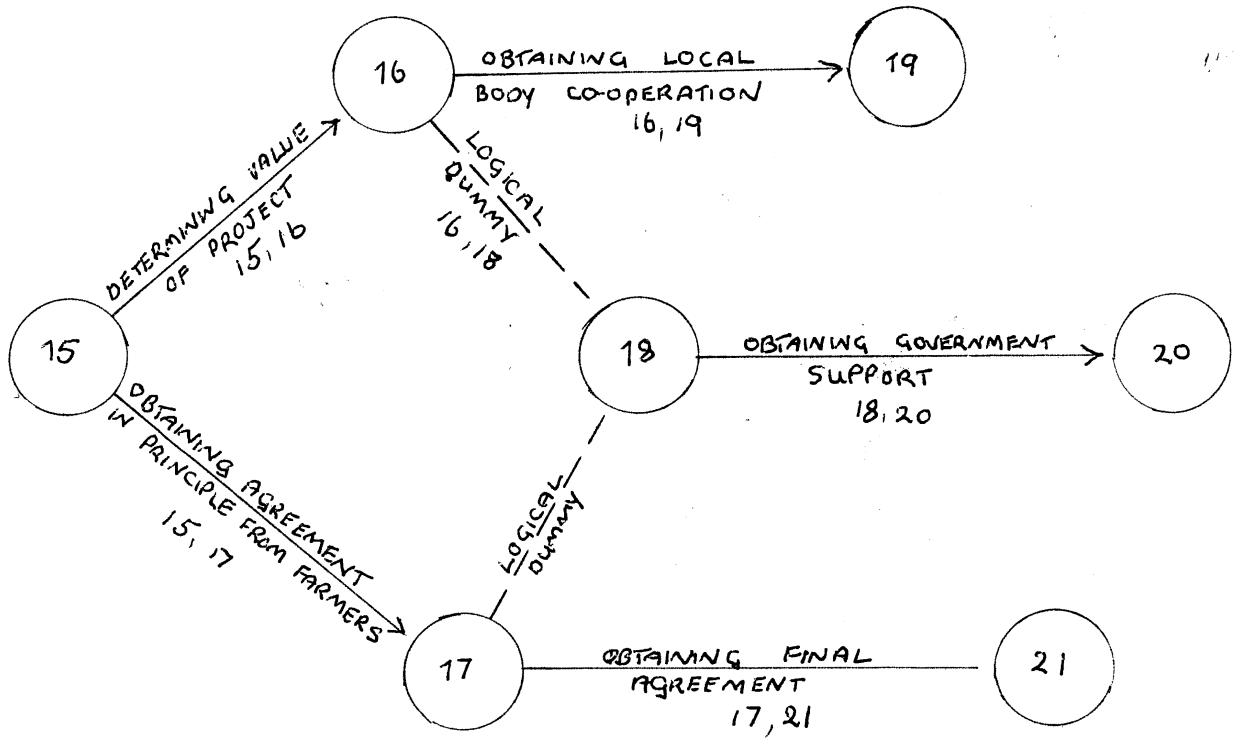


Above we have made "Agreement" 9, 10 and "Dummy" 10, 11. Equally well we could have made "Dummy" 9, 10 and "Agreement" 10, 11.

These dummies which are used to preserve the "ij" numbering system are sometimes called "identity dummies". "Logical dummies" are sometimes required to indicate the logical order of the activities.

The following example shows that one can't start getting government support until such time as the research has been done to determine the value of the project from the national point of view (logical dummy 16,18) and until one has obtained agreement in principle from the farmers (logical dummy 17, 18).

Incorrect sequences of activities may creep in unless logical dummies are used.



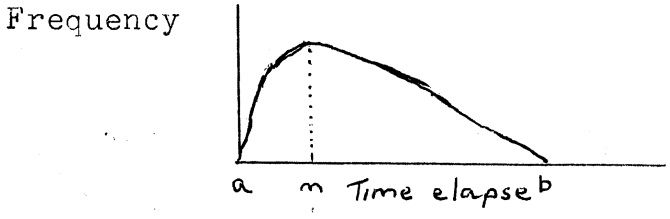
3.0 Estimating the Expected Time Elapse.

After drawing up the complete network, the next step is to estimate the expected time elapse from start to finish of each activity. This can be often done from experience. (If operators name their own estimates for time elapse for an activity there is a tendancy for them to make their estimates come true!)

A more complicated system of estimating time elapse has been suggested by Malcolm et.al. (1959). They suggest making three estimates:

(a) Most likely time elapse (m) (The modal time elapse)
(b) The most optimistic time elapse (a)
(c) The most pessimistic time elapse (b)

Usually the frequency distribution of time elapses for an activity are skewed to the right (positively skewed).



The expected time elapse E(t) is approximated by

$$E(t) \simeq \tfrac{1}{3}\left[2m + \tfrac{1}{2}(a + b)\right]$$

Malcolm et.al. also suggest that the variance of time elapse VAR(t) can be approximated by

$$VAR(t) \simeq \left[\tfrac{1}{6}(b - a)\right]^2$$

Thus suppose that for the construction work of a scheme, the most likely time is 40 weeks (m) but if the contractors had an exceptionally good run the time elapse could be as short as 30 weeks (a). On the other hand if the weather is disastrous and there is a strike as well, the time elapse could be as long as 80 weeks

$$E(t) = \tfrac{1}{3}\left[2 \times 40 + \tfrac{1}{2}(80 + 30)\right]$$
$$= 45$$

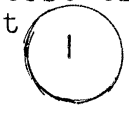
and the variance would be

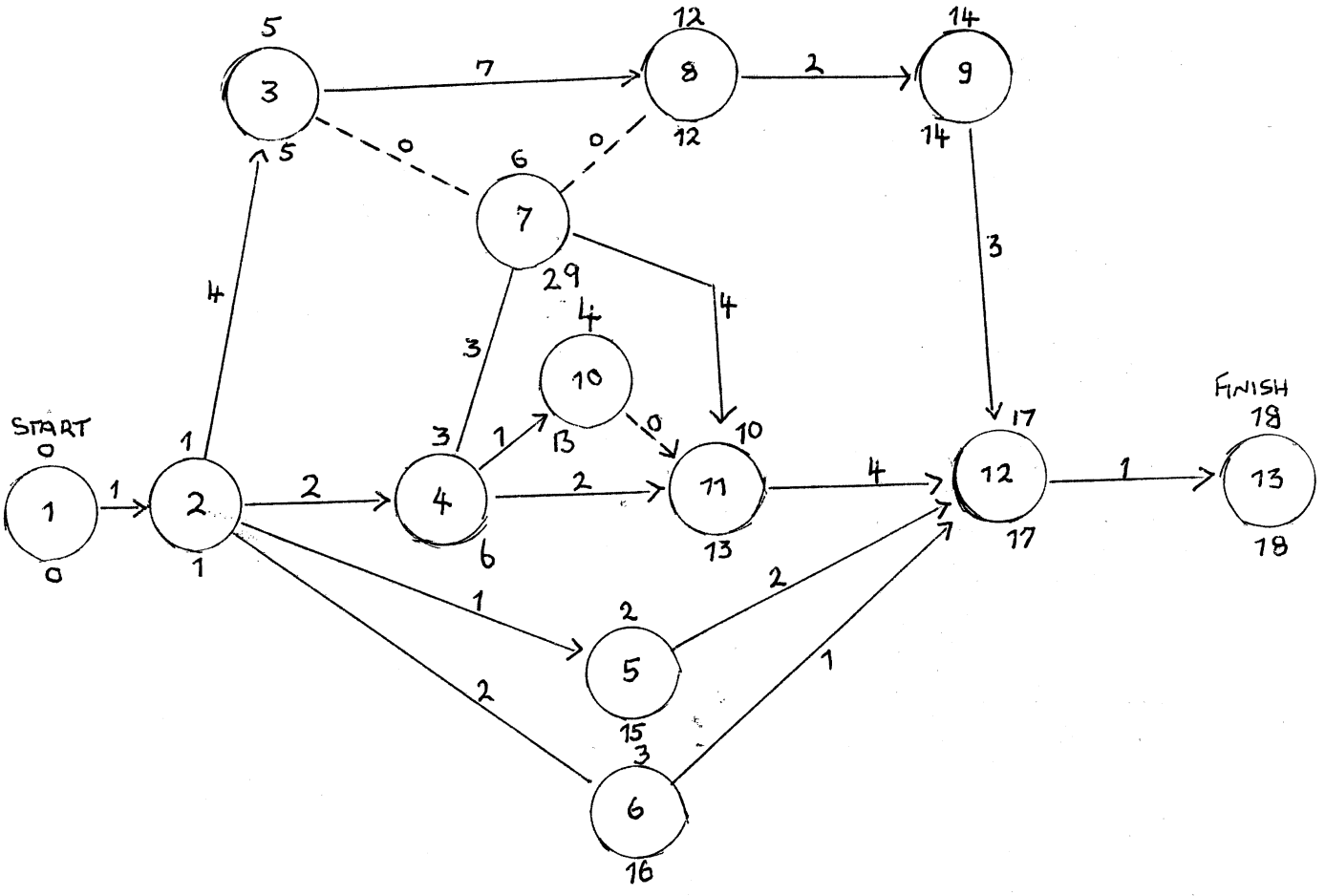
$$VAR(t) = \left[\frac{80-30}{6}\right]^2$$
$$= 70 \text{ weeks}$$

You will notice that if the expected time elapse equation makes the modal time equal the expected time when the modal time is midway between the optimistic time and pessimistic times. For example if a = 30, m = 40 and b = 50, then $E(t) = (2(40) + \tfrac{1}{2}(30 + 50) = 40$.
Having calculated these parameters the next step is to write the time elapses in on the network analysis and determine the critical path.

Determining the Critical Path

We will not complicate matters by trying a network analysis to a particular case. The critical path is calculated by working out the earliest times which each event can occur from the start of the project. Then the latest times for each event are calculated. This is the time at which the event must occur if the completion of the project is not to be held up by that event. We will start with a network which gives the time elapse for each activity on the midpoint of the arrow. The ij code for the activity is given in the table below together with the time elapses. Calculated on the network are the earliest and latest times. These times are measured from zero hour of start

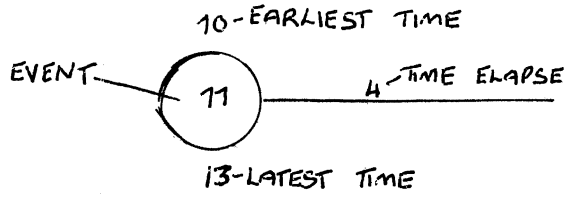




GIVEN INFORMATION

Activity	Time Elapse	Activity	Time Elapse
1, 2	1	10,11	0
2, 3	4	7,11	4
3, 8	7	4,11	2
3, 7	0	11,12	4
7, 8	0	2, 5	1
8, 9	2	5,12	2
9,12	3	2, 6	2
2, 4	2	6,12	1
4, 7	3	12,13	1
4,10	1		

The earliest times are above the node, the latest times below it.



The earliest times are calculated by moving down paths away from (1) in a right hand direction. The next earliest time is merely calculated by adding the time elapse onto the last earliest time. If two or more paths converge on one event, several earliest times are possible. Obviously one selects the maximum earliest time for that event because this is the earliest time which this event can possibly occur.

When all the earliest times have been written in above the nodes, work back from the finish (18) calculating the latest times. In working backwards paths will converge. When two paths converge select the minimum latest time for that event.

The next move is to calculate the slack in each step. This is done by subtracting the earliest time from the latest time at each event node. This difference is called the slack or float. This has been done in the table below.

	Event	Latest Time	Earliest Time	Slack	
Start	1	0	0	0	CRITICAL
	2	1	1	0	
	3	5	5	0	
	8	12	12	0	
	9	14	14	0	
	12	17	17	0	
	4	6	3	3	
	7	9	6	3	
	10	13	4	9	
	11	13	10	3	
	5	15	2	13	
	6	16	3	13	
Finish	13	18	18	0	

The events 1, 2, 3, 8, 9, 12, 13 form the critical path. There is no slack in this path. If events in this path do not occur on time the finish time will be delayed. It is the path that the administrator must keep his eye on. Extra resources may have to be moved into this path if it looks as if the activities in this critical path are running behind time. The other paths are slack. For instance (2, 5, 12) can run 13 time units behind without affecting the finish date.

Total and Free Float.

In some analyses where the term float (associated with an activity) rather than slack (associated with an event) is used, a distinction is drawn between total float and free float. In the path (2, 4, 7) the events 4 and 7 have 3 units of slack in them. But if activity (2, 4) runs 3 units of time behind time, then activity (4, 7) won't have any slack in it. It will have to run on time.

Under the total free float system, the slack is allocated

to the path rather than activity, and is called total float. Total float is synonymous with slack. Thus the path (2, 4 7) has a total slack of 3, and activities (2,4) and 4,7) have a total slack of 3 each, meaning that this is the scare time they can share between them.

Free float allocates all the slack in a path to the last activity in that path and none to the preceding activities. This means that if all preceding activities in a path run on time, the free float belongs to the last activity. None of the preceding activities in a path are given any free float. These are the equations for total and free float.

Total float for an activity ij
= Latest time of event j less Earliest time of event i less time elapse for activity ij.
Free float for an activity ij
= Earliest time of event j less Earliest time of event i less time elapse for activity ij.

Use of Network Analysis

1. Bar Graphs for Control. There are many ways in which information from network analysis can be presented. One way is with a bar graph for controlling the project. An example from a Network Analysis for a Development Research/Extension project is shown.

The administrator can keep an eye on the chart - particularly the critical path to see that none of the steps in the programme fall behind.

2. Cost of Speeding up Project. In speeding up a project it is obviously necessary to allocate effort along the critical path first until other paths become critical. Computer programs are available for calculating stage by stage increases in cost associated with "tightening up the network".

These increased costs can be offset against the increase in return from earlier arrival of the benefits. Traditional discounting techniques can be used to estimate the value of an earlier completed project.

3. Allowance for Uncertainty. The efficiency of the method depends to some extent on the accuracy of the estimates of time elapse. The variance estimates of a path in a project can be calculated from the sum of the variances of time elapse for each activity within the path as calculated earlier. Suppose we return to soil conservation again and imagine three activities in a chain-Planning, Financing and Construction. The variance in months of the path can be calculated as follows.

Activity	Optimistic Time elapse (a)	Pessimistic Time elapse (b)	$(\frac{b-a}{6})^2$
Planning	3	9	1
Financing	6	42	36
Construction	6	24	9
	Total Variance		46

The total variance of the path is 46 and hence the standard deviation is $\sqrt{46} = 7$ approximately. If the expected time for the path is 6 + 24 + 15 = 45 months then we can set confidence limits on this expected time (if we assume a normal distribution).

Expected time = 45 ± 2 standard deviations
= 45 ± 14

Hence the earliest possible time we can expect the path to be completed is 45 - 14 = 31 months, and the latest possible time is 45 + 14 = 59 months.

Concluding Remarks.

Computer programs are available to extract the critical paths, estimate, float, and prepare operating schedules in various forms. Such analyses are run by computer service bureaux. The Lincoln College IBM 1130 has among its software a "Project Control System" based on network analysis which allows for progress reporting and network restructuring during the progress of the project.

There is an excellent programmed learning text available for teaching oneself the procedure of network analysis which, as can be seen from this introduction, are essentially straight forward. I foresee that network analysis will become part of the routine of soil conservation and river control work and I hope that this paper will help conservators understand and perhaps initiate its adoption.

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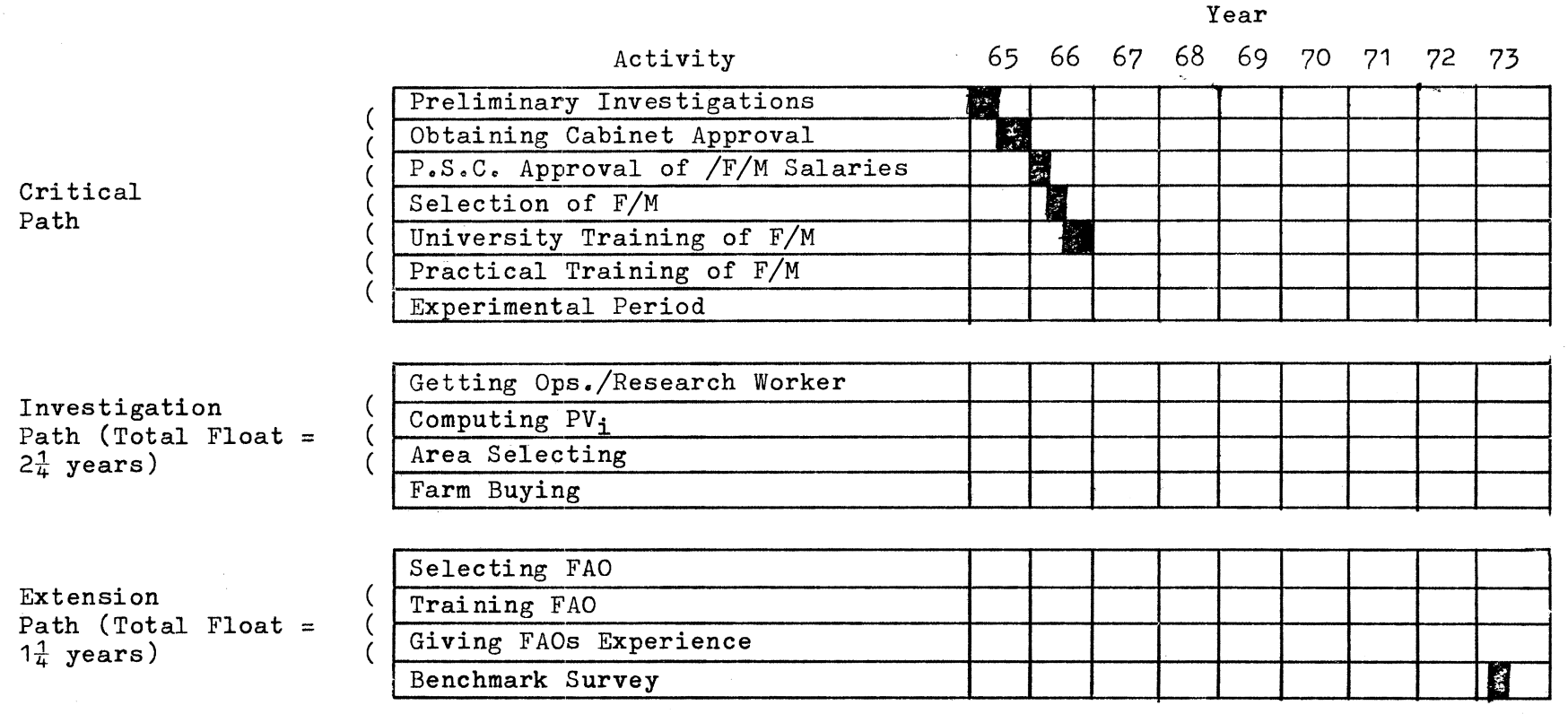
SCHEDULE FOR DEVELOPMENT RESEARCH/EXTENSION PROJECT



INTEGRATED WATERSHED CONTROL

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INTRODUCTION.

Catchments are geographic units within which a wide variety of resources may occur. The resources traditionally recognised in this country have been grazing and agriculture. Today the forest, recreation and water resources are being increasingly recognised and already some catchments are used solely for the development of forestry or water supply. With the exception of catchments with such specialised use-objectives, the problem arises of how best to integrate any one use with any other, so that firstly uses are compromised, and secondly flooding and/or drought effects are minimised. The resolution of this problem is what is involved in integrated watershed control.

PRELIMINARY OBSERVATIONS.

In discussing integrated watershed control in New Zealand, it behoves us to make some preliminary observations. Firstly, New Zealand is a land-hungry nation and therefore allowing for some areas to be set aside as 'bench-mark' or 'reference' areas, each acre should be used to the maximum. However, to combat erosion and to foster the protection and restoration of watershed values, such use must be within the land's capabilities, and such treatment as is necessary should be accorded. There is probably nothing new in these observations, but it is necessary to reiterate them as being fundamental to considerations involving integrated watershed control. A further fundamental concept which must be defined is that for the water resource, downstream demands and influences dictate watershed management objectives in headwater areas. For example the demand may be for a guaranteed supply of quality water as for a municipal supply catchment, and the influence may be the mitigation of flooding. The availability, condition, and control of the water resource - where it's wanted, when it's wanted, and the quality and quantity wanted - is of first importance when discussing total resource management of a catchment.

HOW DO WE GO ABOUT PLANNING FOR INTEGRATED WATERSHED CONTROL?

Traditionally we have done a survey for one particular use. Farm Plans and catchment control schemes have been planned on the basis of land capability surveys, with agricultural or pastoral use in mind. Some attempt has been made at broadening these surveys for application to other uses (Recommended Land Use Maps) but such attempts rely on the capability map in the first instance. The land capability map, or the inventory work done in the preparation of this map, does not provide the full

information that is required in a complete appraisal of the total resources.

For integrated watershed control a complete appraisal of the total resources of a watershed is required. The term 'watershed analysis' is used to differentiate this type of approach from the 'survey' which involves appraisal of only one resource. In watershed analysis the approach is made from the viewpoint of the water resource as this is the resource that is most subtly affected by all other uses.

The objectives of a watershed analysis are firstly to describe and interpret the physical, social, legal and economic characteristics that relate to the total land and water resources of a catchment, and secondly to develop recommendations such that management of the water resource is co-ordinated with other uses. Thirdly, it is essential that recommendations are practical and can be effected.

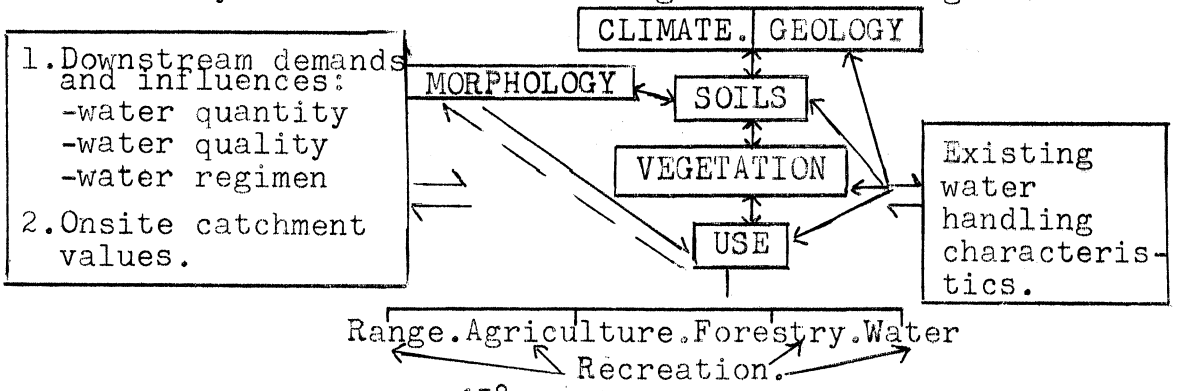
To this end an analysis may be approached by asking six basic questions.

1. What have I got?
2. Where have I got it?
3. What's happening on it?
4. Why is it happening?
5. What does it mean?
6. How do I apply it?

The first three questions involve an inventory of the basic factors that reflect how and why a catchment handles the water that is applied to it. These are the factors affecting the hydrologic cycle and can be generally described as morphology, geology, climate, vegetation, soils and land use. Questions 4 and 5 constitute the interpretive phase of the analysis and as far as the final recommendations go are every bit as important as the basic inventory. The answers to the question "How do I apply it?" result from a careful appraisal of the resources defined in the basic inventory together with the interpretation of their inter-relationship.

INVENTORYING THE BASIC FACTORS.

The basic factors involved and their inter-relationship are clearly shown in the following schematic diagram.



The diagram is shown in the form of a dynamic equation to suggest the interdependence of the basic factors both with onsite and offsite values and with the existing water handling characteristics. With this idea of 'dynamicism' and 'inter-relationship' we are better able to approach inventorying questions of what have I got, where have I got it, and what's happening on it?

Watershed Morphology.

This factor has been largely overlooked in work in this country; yet it is conceivable that when this subject has been fully explored, analysed, and understood, it may be found that an ordinary map of the drainage system provides a reliable index of the permeability of a watershed, and will give some indication of yield. The characteristics of the drainage net (morphological parameters) are discussed subsequently. Unfortunately insufficient research has been done to satisfactorily correlate finite values of the parameters with particular hydrologic characteristics. The determination of morphologic parameters therefore becomes something of an academic exercise. However they are worth calculating for two reasons; firstly, the parameters as such do describe the catchment even if it is difficult to satisfactorily interpret their precise values; and secondly, the parameters may be used in the future for comparison with those of other catchments. In this way knowledge may be built up as to their hydrologic interpretation.

Size and Shape.

Total water yield increases with size, but yield per acre may vary as size increases. For example, the number of aquifers that are intercepted through entrenchment of a drainage system may significantly affect the per-acre yield. Furthermore size influences the maximum and minimum flows. As size increases, maximum and minimum flows generally increase, but may decrease depending on the duration concerned. For example, the 1-hour maximum flow per unit area may decrease as area increased, the 1-day flow may show little trend, and longer durations may show increased flow with increased area. Size therefore is a simple but fundamentally important parameter.

The shape of a catchment naturally effects the hydrology, particularly with regard to the time of concentration of flood events. Although difficult to describe satisfactorily, an index of the form can be determined by calculating the compactness coefficient.*

* Defined as the ratio of the perimeter of the watershed to the circumference of a circle of equal area.

Elevation and Relief.

The area/elevation relationship reveals what acreage is above or below any particular altitude. Climate, soils, and vegetation are all inter-related with the elevation of a catchment. The area/elevation relationship also provides a useful description of the general shape of a catchment. Relief describes the manner in which ridges etc. stand out from a plane surface.

Orientation.

Catchments lying to the south in the southern hemisphere receive less solar radiation than those lying to the north. Their 'angle of repose' also governs the amount of radiation received. Since incoming solar energy may be regarded as the 'engine' which directly or indirectly governs all aspects of the hydrologic cycle, its importance cannot be overstressed.

Stream-orders.

Stream-order analysis gives an indication of channel and drainage characteristics. It is the classification of streams according to the number of bifurcations of the tributaries. All non-branching tributaries, regardless of whether they enter the main stream or its branches are designated as first order. Streams which receive only non-branching tributaries are of the second order, and so on. High ratios of the numbers of first to second order streams etc. indicates steep well drained catchments; low ratios indicate impermeable catchments with efficient drainage.

Length of tributaries.

The length of tributaries is an indication of the steepness of the drainage basin as well as the degree of drainage. In general the lengths of tributaries increase as a function of their order.

Drainage density.

Usually expressed as the length of stream per unit of area, drainage density varies inversely with the length of overland flow and therefore provides at least an indication of drainage efficiency in the catchment.

Constant of channel maintenance.

This is the inverse of drainage density. By knowing this constant an indication of the acreage area necessary to maintain a unit length of channel can be determined.

Stream maturity.

A method has been developed to determine how the mass in a given drainage basin is distributed from base to summit. The percentage hypsometric curve is a plot of the continuous function relating relative height to relative area. Taking the catchment to be bounded by vertical sides and a horizontal base plane passing through the mouth, the relative height is the ratio of a given contour to total basin height. Relative area is the ratio of horizontal cross-sectional area to entire basin area. Two stages mark the evolution of a drainage system in a fluvial cycle:

(a) An early inequilibrium stage, during which slope changes take place rapidly as drainage expands, and

(b) an equilibrium stage in which a stable hypsometric curve develops and persists as relief diminishes. A special 'monadnock' phase may be recognised, but it is transitory and its destruction is followed by restoration of the equilibrium form.

The maturity of a catchment reflects the geologic erosion actively taking place and thus provides an indication of the sediment yields that may be expected.

Climate

The climate information that is generally given with farm plans is rarely sufficient to give but a vague idea of what climatic conditions prevail in the area. Where water yields are an important watershed resource, detailed knowledge of the climate of the watershed is of first importance. Some knowledge of the areal distribution of precipitation in a catchment is essential, and ideally an isohyetal map of the annual precipitation should be prepared. Of equal importance is knowledge of the seasonal pattern of precipitation, duration/frequency/intensity data, and information on trends in precipitation pattern, if such occur. If a recording raingauge exists in the catchment some idea can be obtained of what a typical rainfall event* is - its duration, intensity and amount. It is often useful to plot such data on probability paper so that examination can provide such information as, for example "70% of rainfall events are of less than 20 points and last less than 8 hours".

Only rarely is this type of information available. Most catchments are lucky if they have one non-recording standard gauge within the perimeter. However, better use can be made of the information that even one gauge provides, than just averaging out annual falls. The mean annual fall given by a gauge is a useful figure, but what about

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* A rainfall event is defined as any rainfall of greater than 0.05" which is separated from any other rainfall event by a period of at least 6 hours.

the range over which annual falls occur, or the standard deviation of the annual falls? This information gives some idea of the reliability of rainfall. Season distribution may also be analysed from these figures. The arguement is that the best possible use must be made of what little information is available.

The impact and hydrologic consequences of snow, frost insolation, fogs and other meteorologic phenomena, must also be carefully appraised. The importance of routine and systematic visual observation and recording of such events cannot be over emphasized. Scientific instrumentation is fine, but in its absence useful data may be collated by residents and regular visitors in catchments making a conscious effort to observe and record the weather conditions that prevail.

A watershed analysis serves a useful purpose in pinpointing deficiencies in data such as occur in climate. If necessary, specific recommendations may be made to overcome such deficiencies, but the watershed manager must beware of making recommendation such as these just for the sake of having it on record. Nothing will speed an analysis faster into a "pigeon-hole" than a series of unpractical and non-essential recommendations.

Geology.

Geology influences the natural fertility of the soil and also the natural and accelerated erosion to which a watershed may be subjected. Furthermore, a watershed may be regarded simply as a great mass of rock on top of which is a superficial layer of soil capable of supporting a variety of plant communities which, within certain limitations, may be altered by and for mans' utilization. This "mass of rock" fundamentally influences not only the superficial layer of soil which is essentially the "land resource", but also the water resource to a profound and quantitatively undetermined extent. In any watershed large quantities of water, sometimes representing a large percentage of the total precipitation percolates down into the bed rock where it is subsequently stored, released as base flows to streams, or lost outside the catchment area.

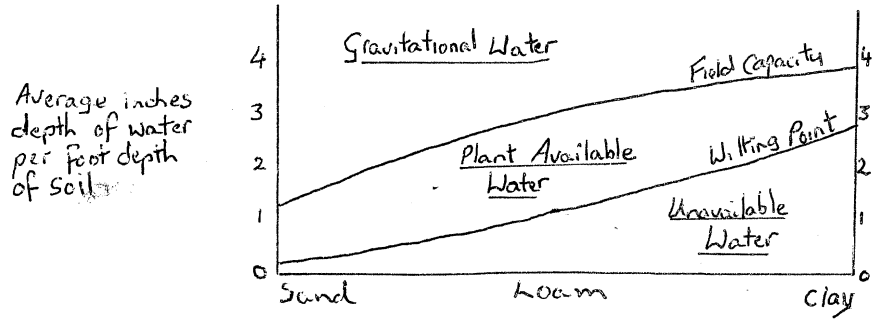
If we are to understand more clearly the water regulatory characteristics of catchments, it is essential we know more about the porosity, permeability and depth of the bed rock as these are the factors that determine the storage potential for water. Until these parameters are determined for different N.Z. rocks it is important that in the first instance the lithology, structure and geomorphology of the catchment are accurately mapped.

Soils.

The identification of the various soils in a catchment

control scheme or farm plan has always been an important phase of inventory work. Careful soil mapping is fundamental to the accurate determination of land capability insofar as pedalogical and edaphological characteristics are concerned. In integrated watershed control this aspect is again emphasized, but recognition is also given to the need to understand those properties which determine the hydrologic characteristics of soils.

Three phases characterise the part soils play in the hydrologic cycle. The first phase covers the initial entry of water into the soil. This infiltration phase is regulated more by pore size than total porosity. Coarse textured soils generally have larger pore spaces than fine textured soils and consequently have higher infiltration rates. However compaction of the surface layers may fundamentally influence the infiltration rates. Clogging of the pores may also occur, and swelling of certain of the clay minerals may alter the infiltration rate with time. The surface conditions may be modified by management practices, but the degree of modification will depend mainly on the kind of soil. The second phase covers the readiness with which water moves through the profile. This permeability is affected by structure, texture, pore space and orientation, clay minerals, pans and other factors. The third phase concerns the soils ability to store water. Storage potential is determined primarily by depth and porosity, i.e. the space available for water in the profile. This stored water may be held in the micropores and be unavailable to plants; it may be held in the macropores and be subject to percolation under the force of gravity; or it may be in a category somewhere between these two classes, representing the so-called 'plant-available' water. This relationship is shown in the following diagram.



From the above discussion we see that the most important hydrologic properties of soils are their porosity, permeability, and depth.

Several alternative methods are available for classifying soils according to their hydrologic properties depending on the kind of hydrologic consideration that is of interest. For peak runoff, the characteristics of most importance are the initial infiltration rate, and the rate at which this decreases. For runoff potential, the Hydrologic Group concept of the U.S.D.A. may be used. This classification is based on the intake of water at the end of long duration storms occurring after prior wetting (allowing opportunity for swelling) without consideration of slope or the protective effects of vegetation. Where the potential waterholding capacity (storage) is of major interest, some estimate may be made of total storage by measuring depth and estimating total porosity from structural and textural information.

In watersheds where water is one of the most important resources it is necessary to produce for the land manager a map showing the hydrologic groupings so that management programmes may be determined. Such a soil-management map may be developed by combining soil hydrologic groupings with slope groupings. The soil management map attempts to categorize areas in the catchment as to their hydrologic rating and their potential for future management. The way in which this information may be used is shown in a detailed extended legend. The approach assumes that water is an important catchment resource and in its application reveals the impact different management systems are expected to have on the water yield. The soil management-area map therefore provides for the setting of priorities for possible vegetation conversion programmes, the hydrologic impact of such conversions, and the basis for estimation of treatment costs.

Vegetation.

Vegetation associations must be adequately described and mapped. More emphasis is needed in describing condition and trend of the associations found in a watershed.

Considerations apart from physical factors.

The above discussion has been based on consideration of the physical factors found within a catchment. If catchments are to be used by man, other human considerations must be taken into account when planning for integrated watershed control. Social, legal and economic factors are of equal importance to the physical factors. Road access, land ownership and tenure, water rights, traditional land-use patterns, and local and national value of specific resources in a catchment are just a few examples.

INTERPRETATIONS.

Returning to the six basic questions, we have now to answer "why is it happening?" and "what does it mean?". It is not the purpose of this paper to discuss the inter-relationships of the various watershed factors, or to interpret what impact changes to one factor will have on any other. Suffice it here to say that in assessing each watershed factor, due and careful consideration must be given to their interpretation. A wrong interpretation may result in a recommendation which involves wastage of private and public money and which in the short and/or long term is of no benefit to either onsite or offsite watershed values.

RECOMMENDATIONS.

"How do I apply it?" The importance of developing recommendations that are practical and which can be effected has already been discussed. In integrated watershed control it is probable that a considerable number of people will be involved in considering and implementing the recommendations. In presenting them keep them concise, to the point, and in a logical sequence.

Clear background information should also be provided behind each recommendation. After all, this in all probability will be the only section of the report that is read.

CONCLUSIONS.

The complete inadequacy of coverage of the topic 'integrated watershed control' is regretted but unavoidable. However it is hoped that this brief introduction has:

- outlined what integrated watershed control involves.
- emphasized the need to look critically at what kind of information is needed when integrated watershed control is envisaged.
- emphasized that this approach involves a team effort involving many disciplines, but that co-ordination and putting into practice probably lies in the soil conservators hands.
- indicated that there is already a necessity for this kind of approach in New Zealand.
- whetted your interest sufficiently that the Executive of your Society will give consideration to providing a full training course dedicated to discussion of the technical aspects of watershed management.

CO-ORDINATION OF AGENCIES AND SUMMARY OF CONFERENCE

D.B. Dallas
District Commissioner of Works
Christchurch

Mr. Chairman, ladies and gentlemen: Last night when I started to marshall my thoughts on the task that faces me at this moment, my mind flashed back many years to the time when I sat the final Section C examination of the Institution of Civil Engineers. The three-hour paper was divided into three major questions. The third comprised about 12 secondary questions that ranged over the whole field of civil engineering.

The instructions at the top of this question said this: "Quite concise answers may obtain full marks. No marks will be awarded for answers that indicate merely a superficial knowledge of the subject, minus marks will be awarded for incorrect guesses".

Later, when I presented myself for the oral examination, or professional interview, the Institution representative confided to me that in his opinion the Section C written paper was designed to test the candidate's reaction to an impossible situation. Perhaps I should add that I made the grade on that occasion.

On this occasion I have listened to something like fifteen well prepared and well presented papers in 2½ days. I always find some difficulty in being critical and creative at the same time, so I think rather wistfully of those papers and wish that right now I was clutching something equally well prepared.

The Course I believe you will agree with me that this course has been a most stimulating experience, and I congratulate the organisers upon the obvious success of their efforts.

Three reasons occur to me as to main ingredients of this success.

First of all is the fact that the three principle executive arms of the Soil Conservation and Rivers Control Service have combined for the first time in a joint stocktaking. This is a tangible acknowledgement - a re-affirmation - of the indivisibility of soil conservation and rivers control in this country. It also highlights points made by Mr. Howe and Mr. Frengley that in the last resort soil conservation and rivers control and its expansion are dependent upon how much of the financial resources of the nation are channelled to this sector of the economy.

And so we have a rounded training course that has dealt

with water and soil and people and their money.

The second reason for success is, I believe, that you have been delving into fundamentals. You have attempted to explore objectives and ends as well as means to the ends and techniques of applying the means.

As Mr. Douglass said, every course should advance beyond the point of previous knowledge or practice. I am sure that this one has done so.

The third reason for success has been the active participation of our hosts and sponsors - Lincoln College. This is recognition of another vital factor in the successful pursuit of your objectives - close teamwork between science and practice. Long may it continue.

A BASIS FOR REMITS

While discussing the general arrangement of the course, may I suggest that next time you should time it for 6-9 months before the Catchment Boards' Conference so that the ideas, the conclusions and the recommendations arising from discussions can be consolidated into a form that could be used by Boards as the basis of conference remits.

I'm not impressed by the standard of conference remits. Too often they give the impression that the topics were decided upon at the last minute and that they have been poorly thought out.

Conferences such as this are an ideal springboard for remits. This could be one way that you could advance and perhaps implement the ideas that you develop here.

CO-ORDINATION AND AGENCIES

The little green card said I was to talk about "Co-ordination of Agencies and Summary of the Conference". In the time available I hope that the result will not be too superficial. What I say will not necessarily represent the official opinion of my Department and it might not clearly separate the consensus of opinion of this conference from my own - but I think you will be able to decide the identity if need be.

Mr. Dick said that it was becoming increasingly realised that the Soil Conservation and Rivers Control Act was a far sighted Act, and he gave some reasons.

I would like to add a few of my own. At the top of the list I would place the constitution of Catchment Boards. Constitutionally and territorially they are the only true regional authorities in New Zealand.

It is futile to attempt to plan regional development,

either physical or economic, except within the framework of central government policy. Authorities established under the Soil Conservation and Rivers Control Act of 1941 are the only ones where the representatives of local and central government meet as equal partners at the same board table to direct the planning, investigation, designing, financing and construction of works ranging in size from a few hundred to some millions of dollars.

Here we have a constructive partnership at regional level where local skills and know-how are actively backed by the full resources of the State and the many agencies and disciplines at its command. This has been a tremendous stride forward in the direction of co-ordination and progress.

Mr. Dick talked about the wide-ranging disciplines involved. This is due to the complexity of the problems you face, as illustrated in discussions during the last two days. Add to this the additional responsibilities arising from the new Water and Soil Conservation legislation and the co-ordination problem is seen to be truly formidable.

PROBLEMS OF CHANGING NEEDS

If there is any suggestion that the new Act represents additional bureaucratic restriction of the rights of the individual, remember a point made by Mr. Collins; the controls that you administer arise from the needs of people, and he went on to say that these needs are continually changing, developing and becoming more complicated. He said the law and the activities of government bodies are merely reflections of these social needs.

Soil conservation and rivers control work involves a series of unique operations or investigations on an endless variety of sites. You have to perform these operations in the most difficult field of private property, private income and soil, climate and markets. This is never going to be easy.

At this time of changing and increasing responsibility, I therefore counsel you to exercise particular tolerance, patience, loyalty and co-operation. Never revert to the we/they attitude. You have your frustrations, such as delegation limits, multiple subsidies, on-cost. Settle these problems and differences at forums like this. Try to prevent Board members criticising the establishment in front of the press at board meetings. There are plenty of outside critics very jealous of your powers and responsibilities. Don't aid them in their tendency to undermine the harmony of the team and the co-ordination of agencies.

LIASON WITH LOCAL COUNCILS

This leads me to mention one important co-ordination requirement that must not be neglected. That is to develop an expanding liaison with local territorial councils. Keep them in the picture when you are planning anything of significance in their areas.

As your new responsibilities develop, your status as a regional authority will depend to a degree on your ability to delegate the local problems. A constructive partnership between the specialist regional authority and the local territorial councils is the final step in the co-ordination of agencies. To achieve this end you now have that excellent section 16(2) of the new Act.

FLEXIBILITY AND INTEGRATION

To facilitate co-ordination, I would like to see some provision for easy interchangeability between Board and Water and Soil Division staff. It could help esprit de corps. It does greatly broaden outlook to see both the local and national picture.

Mr. Dick cautioned against too rigid an administrative system when dealing with the diversity of soil erosion problems. This can apply to operations within your own organisations.

Mr. Collins pointed out that it is unrealistic to think that land-management practises and survey works on the land of a catchment - however desirable they may be for other reasons - can make a substantial difference to the big floods of a large river.

This is obviously true for smaller catchments and is probably true enough for large catchments on the New Zealand scale. It still doesn't mean that a line can be drawn between the lower valley and the upper catchment as a realistic or natural division between the work of the engineer and the soil conservator.

Mr. Watt devoted an entire paper to the topic of integrated watershed control and pointed out the need for the application of many disciplines. To me this means an integrated staff approach to the establishment of objectives and the preparation of proposals.

Think continuously in terms of teams or task forces designed for the particular operation in hand. Be able to re-group whatever disciplines are involved for the next task. Don't become do-it-yourselfers.

RATING ACCORDING TO BENEFIT

The second reason why I believe the 1941 Act was far

sighted is in the provision for rating according to benefit. I suppose that even a single-unit work should not be undertaken unless the benefit is fairly obvious in relation to cost.

I have looked hard at the possibilities of a general works rate - maybe a land tax - over the whole region to finance what I call the "stitch-in-time" jobs that give no obvious direct or immediate benefits, but have a long term cumulative result; but I cannot make it stick. Whether cost benefit analysis would justify that approach I don't know, but for all normal operations the Act directs you towards cost benefit analysis. This is a rational guide to decision making regarding the diversity of expenditure and I will return to this later.

LAND CAPABILITY AND NEEDS

At this point, I want to mention where I think there is one gap in your procedures. Land inventory and land capability mapping is a sound basis for assessing resources. What should follow is the type of thing we have established on a national scale in roading - a ten-year needs survey.

Suppose you have the whole country covered by land capability maps, the next step would be to schedule the needs in priority order and to develop, say, a three-year programming procedure.

CRITERIA FOR PRIORITY

Frankly, I think this is where you encounter one of your two greatest problems. Just what is the basis of priority? On river and drainage projects I think cost benefit analysis can give a good guide. What about in the catchments?

Mr. Greenall dealt with some of the criteria there. Mr. Bradfield said that his Board did not set out to develop farm plans that gave the greatest economic return - but rather selected the worst erosion and then proceeded by invitation or persuasion.

At the other end of the scale, Mr. Hughes asked whether there should not be more emphasis on prevention. Could a farm plan then be no more than advice on preventive measures? There is a delicate balance between prevention and cure. Mr. Frengley's graphs raised this question - when is it improvement and no longer conservation and on which side of the line should soil conservation and rivers control funds be applied.

Mr. Warrington thinks it is difficult to assess and to separate soil conservation results from normal improvements.

Priority to the worst erosion surely must be related to costs and benefits. So there are some of the problems in priority setting. Can you use cost benefit analysis as a

guide to priority setting in catchment control schemes or will its use be restricted mainly to a comparison of methods?

DEFINING OBJECTIVES

The priority question is very close to your other major problem of the objective. Mr. Greenall and various other speakers expounded the objective of improved production. To me this means Mr. Frengley's graph going upwards beyond the point of mere stability and I wonder how you win friends and influence people in the Fields Division of the Agriculture Department if you expand into that area.

During the discussion on subsidies, Mr. Hughes said the criterion was that the farmer should be no worse off after soil conservation than before. Perhaps his farm should be no better off except in relation to its capacity to resist erosion and to its potential for increased production on that account.

Of course, it might be a problem of runoff affecting a lower catchment and not a problem of erosion. It may be, and frequently is, a complex problem of many things from which the objective emerges as the plan of operations. Several speakers, including Mr. McArthur and Mr. White, highlighted the great importance of defining objectives and Mr. Douglass spoke words of wisdom when he said how easy it is to get work done when the objective is easily defined and cost benefit analysis can be readily applied. How comparatively simple it is to define a building proposal of the same value, or a piece of road construction, or even an irrigation scheme.

COST-SHARING

Mr. Frengley dealt with the theory of subsidies and established quite clearly that finance is a resource and it has the function of a universal measure. It can be applied in such a way that a balance of satisfaction can be achieved more or less.

I would say that Mr. Frengley convinced you that subsidy on investment is far preferable to price support, although the present method of cost sharing is not necessarily the most desirable.

The suspensory loan idea was introduced and appeared to be widely favoured and you considered that it should be investigated further. Here again, I believe cost benefit analysis could help you to decide when its use would be desirable. Extend the idea to developing rating areas for a group of farms in the catchment on a classification basis, or by agreement, raising the local share by loan. Test the possibility by cost benefit analysis.

The point was made that it doesn't matter where the

money comes from or what the subsidy rate: this doesn't affect the result of cost benefit analysis. Mr. Jensen made special reference to this when he said that the economic desirability of a scheme must be entirely separated from the question of subsidy or source of finance.

Most of us have encountered examples within boards of pressure to embark on a work that cannot be financed on standard rates of subsidy. Sometimes the pressure is passed on to the powers-that-be to make special subsidies available. Usually this occurs with works that won't stand up to cost benefit analysis. The real problem is not one of subsidy rate at all because even if a group of ratepayers was well enough off to need no subsidy, they would not invest their money if an analysis indicated no benefit and possibly a loss.

In the discussion on Mr. Warrington's paper, the point was made that the financial assistance offered is relatively small in relation to gross farm turnover and could be regarded as the inducement for the farmer to accept technical guidance. I would put it this way: it persuades him to accept nationalised farming without national ownership. This is no doubt the reason why any type of farm plan used to be shunned by influential board members in some districts. As well as inducing the farmer to accept guidance, the contribution of public funds encourages accelerated instead of slow treatment of the problems.

MULTI-RATE SUBSIDIES

There has been a great deal of criticism of the multi-rate subsidies. Frankly, I doubt whether it is practical to condense them greatly.

I think of our architectural contracts and the accompanying schedules of quantities. The multitude of rates produced by quantity surveyors have been criticised and the question has been asked, why not one unit price for a building of, say, 200,000 sq.ft at £14 per sq.ft?

Surely, you must have unit rates for single purpose treatments, or for varying the proportions of different treatments so that a plan can be flexible through the process of feed-back. If cost benefit analysis was feasible, I doubt whether it would prove that all classes of work warranted the same subsidy.

With every farm plan composed of an infinitely variable proportion of factors, what other way is there of arriving at the total value of the government share? It is annoying I know, but the problem needs more thought.

I think it was accepted in principle that there should be no subsidy for river work unless soil conservation work was included, but how do you bring the catchment in if it has no soil conservation problem and you have to rate on

benefit?

Then you have single purpose board works. It seems that there must be an arbitrary decision as to when the scheme is to be a comprehensive catchment control scheme.

Whether it is or not, it is desirable to make the initial examination by a composite team from all disciplines likely to have a contribution to make. I think there was fairly general agreement that the scheme to be put forward should be the most effective scheme, whatever it might involve.

Mr. Douglass's committee was to summarise the result of the workshop on Tuesday, and I won't mention it here except to refer in passing to the old bogey of on-cost. Wouldn't the tidiest procedure be for the Council to subsidise the administrative rate on a 50/50 basis and thus seal the partnership bond.

MAINTENANCE AGREEMENTS

Before I leave the topic of subsidies entirely, I suggest that no public money should be invested in works unless there is reasonable provision for future maintenance. This can be arranged through the farm improvement agreement. In principle, also, the agreement should, I believe, provide for assistance in applying a cure - if some sort of cost benefit analysis shows it to be worthwhile - on condition that the farmer simultaneously takes any steps necessary about prevention.

DELEGATION

The three problems of objectives, priorities and subsidies are at the root of the delegation issue.

The complexity of the field in which you work, the scope for different interpretations in relation to that limited resource, finance, occasionally the question of confidence in local handling of the situation, all call for caution in delegation. Also, when almost all your operations depend on persuading people to place their own funds in your hands, it is not too unreasonable to double check your plans until the continued growth of public confidence can never be in doubt.

Try to educate the committees of the board not to delve technical details of the scheme that concern you and the farmers, but to seriously check its justification - to be more concerned with what is to be done than how it is to be done.

In May 1967, in a policy report to the Commissioner of Works a short section on soil conservation and rivers control concluded with a paragraph in which I said that as knowledge and techniques became more firmly established and accepted

"the catchment board as an institution is more competent than other local authorities to receive 100% delegation of bulk allocations, subject to an inspection right by departmental officers."

MANAGEMENT EFFICIENCY

I want to conclude with some comments designed to highlight the papers of Messrs. Frengley, Jensen, Norton and McArthur. They form a complementary group that are not so much concerned with the mechanics of your industry, to use a comprehensive term, nor even with its technical problems, as with applying the management efficiency and polish that can set Boards in the front rank in the Local Authority field.

COST BENEFIT ANALYSIS

During discussion of one of the last mentioned papers, there was mention of the danger of easily evaluated projects attracting the finance. I doubt whether this is a real danger. I think it was made clear enough that cost benefit analysis must be used as a guide and not necessarily as the final arbiter.

Public policy, social ethics, judgement about future economic conditions, intangible benefits, all ensure that policies or government judgement will finally decide the question of relative social utility.

Cost benefit analysis is an indispensible tool and its use should be expanded. Uniformity of procedures is desirable and sensitivity analysis should be applied to arrive at an order of accuracy figure. All these points have been covered in the papers or discussion.

A question brought out the fact that cost benefit analysis can proceed by stages. In fixing priorities of catchment control schemes, it would be impossible to apply detailed analysis in the preliminary sorting process. This is a normal government approach to authorisation of major projects - preliminary assessment determining the desirability of authorising a further degree of investigation.

It was accepted, I think, that the primary use of cost benefit analysis would be in the comparison of alternatives or for decisions on priority and the channelling of funds, not to decide whether a project in itself should proceed.

PROGRAMMING

So finally we arrive at Mr. McArthur's programming. First applied to the human network involved in the scheme acceptance and decision making process and, secondly, applied to the execution phase of the operation itself.

Lack of programming is often one of the greatest gaps

in the management process and yet few of the tools of management can pay greater or more immediate dividends. It can give us optimum utilisation of resources to achieve objectives in the minimum desirable time. It can be used at all levels from strategic planning stage down to the level of the foreman's weekly programme.

LAND PLANNING PROVISIONS

Switching to a different type of planning, and in reply to discussion on the paper presented by Mr. Durant, there is no reason why town and country planning legislation should not be used to reserve certain areas for forestry as distinct from pastoral or agricultural use. This can be achieved by designating a special rural zone in the district planning scheme. It would first involve making a requirement that could be subject to objection and appeal and could possibly, but not likely, involve payment of some compensation.

CONCLUSION

If you have absorbed and can apply even half the wisdom that has been made available through the proceedings of this training course the Catchment Board movement, even with Water Board responsibilities added, will continue to grow from strength to strength.